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OF

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AND

EXERCISES

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PREPARING FOR EXAMINATIONS.

BY

THOMAS W. PIPER,

LECTURER ON ARITHMETIC IN ST. KATHARINE'S TRAINING COLLEGE, TOTTENHAM;

Author of

"Mental Arithmetic for Training Colleges," and other Works

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PREFACE.

This book consists of Examples and Exercises, and is intended to supply a progressive and properly-graduated course of Arithmetic. It is hoped that the book will be found especially suited to the wants of Middle Class and Higher Schools: that it may also commend itself for use in Training Colleges and by Pupil Teachers, is my wish and design.

As the book has been written for use with my Advanced Arithmetic or some other text-book, I have not here repeated the examples of methods which such books supply; I have tried rather to supplement those examples with others showing shorter or otherwise more convenient methods. Properly to understand the geography of a mountain it is necessary to climb it on different sides and to cross it in different directions; and fully to understand an arithmetical problem it is, at least, convenient to consider it from more than one point of view and to work through it in different ways. For this reason I have made it a point to show more than one method of working individual sums.

The *Exercises* are intended to be continually progressive and continually recapitulatory. The miscellaneous exercises which I have given here and there through the book, and in which

comparatively easy work is provided in the midst of greater difficulties, will serve as resting places for the pupil, even as a stretch of more open country gives rest to the soldier wearied with a march through rugged hills, and renews his strength and his spirits for the still more difficult march in the distance before him. And just as an able general would take advantage of this opportunity for remedying such defects in his forces as the previous march had discovered, so the careful teacher will take advantage of these easier exercises to give such further explanations of elementary principles and operations as he sees are needed.

The Appendix contains a number of papers which have been set in various examinations by public bodies. These supply a very useful collection of miscellaneous exercises, and will, I trust, be of special service to students preparing for such examinations.

T. W. P.

TOTTENHAM, August 1882.

EXAMPLES AND EXERCISES IN ARITHMETIC.

Example I.

If 2 tons of coal cost £2, 3s., what will be the cost of 3 tons?

Method.

Here, £2, 3s. 0d. = cost of 2 tons;
therefore,
$$\frac{£2, 3s. 0d.}{2}$$
 = cost of 1 ton;
therefore, $\frac{£2, 3s. 0d.}{2}$ × 3 = cost of 3 tons.

Working.

EXERCISE 1.

- 1. What is the value of 8 horses at £38, 19s. 8½d. each?
- Find the cost of 11 tons of sugar at sixteen pounds, nine shillings, and eightpence halfpenny per ton.
- Add together the cost of 7 houses at £193, 13s. 4d. each, and 9 pieces of land at £80, 19s. 6d. each.

^{*} The pupil must clearly understand that $\frac{\pounds 2}{2}$ is another way of writing $\pounds 2$, Se, $\theta d. + 2$.

- 4. If the cost of an acre of land be £26, 13s. 7½d., what will be the cost of 87 acres?
- Multiply £80 by 12, and take from it the price of 7 horses at £62, 10s. 6d. each.
- 6. What will be the cost of 4 houses if the cost of 3 be just £1000?
- 7. Nine acres of land are worth £1500; what is the value of 7 acres?
- 8. If 5 horses be worth £1523, what is the value of 11 horses?
- Find the value of 7 tons of wood when 5 tons are worth £95, 11s. 3d.
- 10. What will be the value of 8 bushels of wheat when 17 bushels are worth £12, 16s.?

Example II.

What will be the value of 28 cwt. of coals if 7 cwt. be worth 8s. 2d. ?

1st Method (the same as in Exercise 1).

Here, 7 cwt. are worth 8s. 2d

therefore, 1 cwt. is worth 8s. 2d.

therefore, 28 cwt. are worth $\frac{8s. 2d.}{7} \times 28.$

2d Method.

Since, 28 cwt. = 4 times 7 cwt., it follows that the cost of 28 cwt. = 4 times the cost of 7 cwt.; therefore, the answer, = 4 times 8s. 2d. = £1, 12s. 8d.

EXERCISE 2.

 If 12 tons 8 cwt. of coal can be bought for £10, how much coal can be bought for £50?

 A cubic foot of stone weighs 11 cwt. 13 lb., what will be the weight, in pounds, of 19 cubic feet?

3. Five cubic feet of water weigh 312 lb. 8 oz., what will be the weight of 25 cubic feet?

- 4. Three cubic feet of water weigh 6 qr. 19 lb. 8 oz.; what will be the weight of 1 cubic yard?
- 5. If 18 Turkish cannon cost the Sultan £7300, what will be the cost of 23 such cannon?
- 6. Find the value of $\frac{18 \text{ tons 9 cwt. 3 qr. 20 lb.}}{11} \times 16$
- What will be the cost of 118 casks of brandy if the cost of 73 casks be £255, 10s.?
- 8. If the cost of 101 acres of land be £96,048, 17s. 11d., what is the price per acre?
- 9. In how many hours will a man earn £96 if he earn £19, 5a. in 11 days of 6 hours each ?
- 10. How many cubic feet of timber can be bought for £73, 6s. if the price of 19 cubic feet be £4, 0s. 9d.

Example III.

The price of a ton of coal being £1, 7s. 6d., what will be the cost of $4\frac{1}{4}$ tons?

1st Method.

- (a) Find the cost of 4 tons by multiplying £1, 7s. 6d. by 4;
- (b) Find the cost of 1 ton by dividing £1, 7s. 6d. by 2;
- (c) Add the two results together, and thus find the cost of 41 tons.

2d Method.

- (a) Find the cost of \(\) ton by dividing £1, 7s. 6d. by 2;
- (b) Then, since 41 tons = 9 half-tons, multiply the result by 9.

Workings,

1st Method.

£ s. d.

1 7 6

4

5 10 0 = cost of 4 tons.

13 9 = cost of
$$\frac{1}{2}$$
 ton.

Answer, 6 3 9 = cost of $\frac{1}{2}$ tons.

EXERCISE 3.

- 1. What will be the cost of 71 gallons of wine at 19s. 9d. per gallon ?
- 2. Multiply £7086, 16s. 10d. by 15\frac{1}{2}.
- 3. Multiply £83,847, 16s. 9d. by $9\frac{1}{2}$.

4. Multiply £6032, 18s. 41d. by 91.

5. Multiply 7806 tons 17 cwt. 2 qr. by 81.

- 6. If 2 tons 18 cwt. of coal can be bought for £1, how much coal can be had for £9, 10s. ?
- 7. 90 miles 7 fur. 38 poles \times 194.
- 8. 109 miles 4 fur. 30 poles \times 61\frac{1}{4}.

9. 26 yd. 2 ft. 11 in. \times 17 $\frac{1}{2}$.

10. How much sugar can be purchased for £12, 10s. if 3 cwt. 2 qr. 6 lb. can be had for a sovereign ?

Example IV.

Multiply £30, 16s, 8d, by 7\frac{3}{2}.

1st Method:

(a) Multiply £30, 16s. 8d. by 7.
(b) Multiply £30, 16s. 8d. by ½; i.e., get ½ of it; i.e., divide it by 2.
(c) Multiply £30, 16s. 8d. by ½; i.e., get ½ of it; i.e., divide it by 4.

(d) Add together the results found under (a) (b) (c).

Working.

30 16 8 215 16 7 times £30, 16s. 8d. 7 14 2 = £30, 16s. 8d. $\div 4 = \frac{1}{4}$ of £30, 16s. 8d. 238 19 2 = £30, 16s. 8d. \times 7\frac{3}{2} = Answer.

2d Method.

(a) Reduce 7% to an improper fraction; thus, 7% = \$\frac{1}{2}\$ (b) Multiply £30, 16s. 8d. by 31, and divide the result by 4.

^{*} Before proceeding to this exercise the pupils must have been carefully shown how to convert a mixed number into an improper fraction.

Working.

EXERCISE 4.

- 1. Multiply £70,603, 19s. 9d. by 84.
- 2. Multiply £26,063, 10s. 9d. by 27%.
- 3. Multiply £91, 10s. 73d. by 683.
- 4. 6135 yd. 1 ft. 9 in. \times 883.
- 5. 26 miles 3 fur. 28 po. \times 713.
- 6. 38 miles 6 fur. 32 po. $\times 28\frac{1}{4}$.
- 7. 81,018 tons 7 cwt. 2 qr. 16 lb. 10 oz. × 39%.
- 8. 48 tons 19 cwt. 2 qr. $11 \text{ lb.} \times 17\frac{1}{4}$.
- 9. 20 miles 7 fur. 36 po. \times 191.
- 10. If a train travel 21 miles 3 fur. in an hour, how far will it travel in 61 hours 30 min. ?
- 11. A snail is crawling at the rate of 31 ft. 8 in. per hour, how far will it travel in 8 hours 30 min.?
- 12. If a silver watch be worth half as much as a gold one, what will be the cost of 17 silver watches and 9 gold ones when the price of a silver watch is £5, 15s. 6d. ?

Example V.

Multiply £15, 6s. 4d. by $3\frac{1}{8}$.

The Methods in this case will be apparent from the workings:-

£ s. d.
(i.) 15 6 4

$$\frac{3}{3}$$

 $\frac{45 \ 19 \ 0}{1 \ 18} = \frac{£15, 6s. 4d. \times 3}{3 \ 2} = £15, 6s. 4d. \times \frac{3}{4}$.
 $\frac{47 \ 17}{3 \ 2} = £15, 6s. 4d. \times 3 \ 2 \ 4 \ 4 = Answer.$

٤

Exercise 5.

- 1. £27, 10s. $0\frac{1}{2}$ d. $\times 6\frac{1}{3}$.
- 2. 89 tons 19 cwt. 2 gr. 10 lb. × 31.
- 3. £88, 19s. 8d. × 61.
- 4. $1800 \text{ yd. } 2 \text{ ft. } 9 \text{ in. } \times 8\frac{1}{9}$.
- 5. 19 lb. 3 oz. 4 dwt. × 2\frac{3}{2}.
- 6. 251 tons 19 cwt. 2 qr. 9 oz. × 31.
- 7. 28 tons 7 cwt. 2 qr. \times 10 $\frac{1}{7}$.
- 8. 805 tons 16 cwt. $\hat{1}$ qr. 18 lb. \times 9 $\frac{1}{8}$.
- 9. £909, 17s. $3\frac{1}{2}$ d. × $25\frac{3}{4}$.
- 10. 73 lb. 6 oz. 18 grains × 83.
- 11. How many pecks of green peas can be had for 19s. 8d. if 3 pecks cost 1s.?
- From 180 tons 2 cwt. 3 qr. 16 lb. take 73 tons 2 cwt. 3 qr. 21 lb.; multiply the remainder by 7/5, and then add 36 tons 2 qr. 7 lb. to the product.

Example VI.

Multiply £40, 5s. 3d. by 85.

The Methods in this case will be apparent from the workings,

(i.) Since $8_7^5 = \frac{61}{7}$, we have

£40, 5s. 3d
$$\times$$
 8\frac{4}{5} = £40, 5s. 3d. \times \forall .

£ s. d.

40 5 3

10

402 12 6 = £40, 5s. 3d. \times 10.

6

2415 15 0 = £40, 5s. 3d. \times 60.

40 5 3 = £40, 5s. 3d. \times 1.

7 | 2456 0 3 = £40, 5s. 3d. \times 61.

850 17 2\frac{1}{2} = £40, 5s. 3d. \times 8\frac{1}{7} = Answer.

£ s. d. (ii.) 40 5 3 $3\overline{22}$ 0 = £40, 5s. 3d. × 8. $0_7^2 = £40$, 5s. 3d. $\div 7 = £40$, 5s. 3d. $\times 7$. 5 15 23 $1^{4}_{7} = £5$, 15s. 0^{4}_{7} d. $\times 4 = £40$, 5s. 3d. $\times 4$ 21 = Answer850 17 = £40, 5s. 3d. × 8\$.

EXERCISE 6.

1. £83, 17s. $0\frac{1}{2}$ d. \times $6\frac{1}{3}$.

2. £2288, 19s. 101d. × 61.

3. £202, 19s. $10\frac{1}{2}$ d. × $13\frac{7}{8}$

4. 2000 yd. 1 ft. 7 in. × 81 ½.

5. 17 poles 3 yd. 1 ft. 9 in. × 7\frac{3}{4}.

6. £819, 19s. $7\frac{1}{2}$ d. × $17\frac{3}{2}$.

7. $[£19, 10s. 1\frac{1}{2}d. + £120, 0s. 10\frac{3}{2}d.] \times 11\frac{1}{2}$.

8. £243, 19s. $9_{\frac{1}{2}}^{2}$ d. × $6_{\frac{7}{8}}^{7}$.

9. £6090, 17s. $\bar{0}_{10}^{2}$ d. × $\bar{9}_{10}^{7}$.

10. £3419, 12s. $8\frac{7}{4}$ d. × $5\frac{7}{8}$.

11. 1096 miles 6 fur. 30 po. × 87.

12. £27396, 4s. $4\frac{3}{7}$ d. × $71\frac{3}{8}$.

Example VII.

Multiply £16, 4s. 8d. by 11 §.

1st Method.

(a) Reduce 115 to the Improper Fraction .

(b) Multiply £16, 4s. 8d. by 93 and divide the result by 8.

2d Method.

(a) Multiply £16, 4s. 8d. by 11.

(b) Divide £16, 4s. 8d. by 8, thus obtaining 1 of £16, 4s. 8d.

(c) Multiply the result obtained in (b) by 4, thus obtaining 4 of £16, 4s. 8d.

(d) Add together the results obtained in (a), (b), and (c) and thus get the answer.

N.B.—The above two methods are similar to those shown in Example VI., but when, as in the present example, the denominator of the fraction in the multiplier is an even number, the 2d Method may be varied, as follows:—

8d Method.

(a) Multiply £16, 4s. 8d. by 11.

(b) Since \(\frac{1}{2} = \frac{1}{2}, \) divide £16, 4s. 8d. by 2, and thus obtain \(\frac{1}{2} \) of £16, 4s. 8d.

(c) Divide the result obtained in (b) by 4, thus obtaining 1 of £16, 4s. 8d.

(d) Add together the result obtained in (a), (b), and (c) and thus obtain the answer.

EXERCISE 7.

1. £9099, 19s. 03d × 1013.

2. 303 miles 6 fur. 14 po. × 937.

3. 707 tons 13 cwt. 1 qr. 16 lb. \times 16%.

4. 23 tons 17 cwt. 2 qr. 18 lb. x 71.

5. 8189 tons 14 cwt. 2 qr. 11 lb. \times 3½.

6. £603, 18s. $1\frac{1}{4}$ d. × $1\frac{7}{8}$.

7. £803, 19s. $1\frac{1}{2}$ d. × $707\frac{7}{10}$.

8. 13 miles 6 fur. 2 po. 5 yd. 2 ft. 11 in. \times 96 $\frac{9}{10}$.

9. 18 miles 2 fur. 13 po. 4 yd. 2 ft. 7 in. \times 7 k.

10. 16 miles 4 fur. 13 po. 8 in. \times 68 $\frac{3}{8}$.

11. 18 tons 3 cwt. 2 qr. 11 lb. \times 108 $\frac{3}{5}$.

12. 16 tons 13 cwt. 1 qr. 17 lb. $\times 25\frac{5}{11}$.

Example VIII.

Multiply 13 tons 2 cwt. 40 lb. by $8\frac{5}{9}$.

1st Method; same as 1st Method of Example VII.
2d Method; same as 2d Method of Example VII.

8d Method; an adaptation of 3d Method of Example VIL

Working.

4th Method.

(a) Multiply multiplicand by 8.

(b) Multiply multiplicand by 5 and divide the result by 9; thus obtaining } of multiplicand.

(c) Add together the results obtained in (a) and (b).

Working.

t. 13	cwt. 2	1b. 40 8	02.		t. 13	cwt.	1b. 40 5	02.	
104	18	96	$=$ multiplicand \times 8.	9	65	11	88		
7	5	84	$7\frac{1}{9} = \text{multiplicand} \times \frac{5}{9}$.		7	5	84	7	
112	4	68	$7\frac{1}{2} = \text{multipd.} \times 8\frac{1}{2} = Answer.$						

EXERCISE 8.

- 1. £190189, 19s. $7\frac{1}{2}$ d. × $5\frac{3}{4}$.
- 2. [£700617, 10s. 3d. £9109, 19s. 8\flactdd.] \times 10\frac{3}{2}.
- 3. 42 tons 7 cwt. 2 qr. 21 lb. \times 61\frac{1}{2}.
- 4. If a parcel be carried 84 miles for £1, how far would it be taken for £17, 10s. at the same rate?
- 5. 9697 tons 13 cwt. 106 lb. 10 oz. \times 909 $\frac{1}{2}$.
- Find the price of 86¾ gallons of wine when £1, 13s. 6d. is the cost of 3 gallons.
- 7. 2 miles 1 fur. 17 po. 2 yd. $\times 12\frac{3}{8}$.
- 8. 8 bush. 3 pk. 1 gall. × 91,3.
- 9. 51 bush. 3 pk. 1 gall. \times 773.
- 10. 18 miles 7 fur. 19 po. \times 86\frac{3}{3}.
- 11. 18 tons 14 cwt. 2 qr. 7 lb. \times 65 $\frac{4}{9}$.
- 12. 21 miles 5 fur. 10 po. 2 yd. 1 ft. 10 in. × 89.3
- 13. 33 miles 2 fur. 17 po. 4 yd. 7 in. \times 777.
- 14. 61 miles 7 fur. 5 yd. 1 ft. 5 in. \times 36 \times 5\frac{1}{2}.

Example IX.

What is the cost of $7\frac{4}{5}$ tons at £5, 12s. 6d. per ton?

Besides the methods mentioned under Example VII., the following workings exhibit two new methods:—

Working.

= $\pounds^{\frac{35}{8}}$. = £48, 17s. 6d. Answer.

(ii.) The price of $7\frac{4}{7}$ tons at £1 per ton = £7 $\frac{4}{7}$ = £7, 16s. we thus find that

$$\mathcal{L}$$
 s. d. 7 16 0 is the cost at £1 per ton. 5

 $39 \quad 0 \quad 0 =$ the cost at £5 per ton. $10s. = £\frac{1}{2}$; ... $3 \quad 18 \quad 0 =$ the cost at 10s. per ton.

28. 6d. = $\frac{108}{4}$. · · 19 6 = the cost at 2s. 6d. per ton.

48 17 6 = the cost at £5, 12s. 6d. per ton = Answer.

Exercise 9.

What is the cost of—

8³/₆ tons at £4, 7s. 6d. per ton?
 7⁴/₉ cwt. at £7, 4s. per cwt.?

3. 18\(\frac{2}{3}\) acres at £283, 19s. 6d. per acre?

4. 88 ac. 3 rd. at £220, 10s. per acre?

5. 28 tons 10 cwt. at £36, 10s. per ton?

6. 39 yd. 1 ft. 6 in. at 7s. 6d. per yd. ? 7. 26 tons 5 cwt. at £18, 10s. per ton ?

8. 193 yards of carpet at 4s. 71d. per yd. ?

Example X.

Divide £8, 5s. 4d. by $1\frac{1}{7}$.

Divide £8, 5s. 4d. by $\frac{3}{7}$; = Multiply £8, 5s. 4d. by $\frac{1}{8}$.

The answer can then be found by methods already indicated in Examples VIII. and IX.

EXERCISE 10.

- 1. £6000, 0s. 5d. $\div \frac{103}{108}$.
- 2. £803,642, 19s. 6d. $\div 2\frac{3}{5}$.
- 3. £3741, 10s. $9\frac{1}{2}d. \div 3\frac{1}{4}$.
- 4. £4,138,257, 10s. $3\frac{1}{2}d. \div 3\frac{2}{7}$.
- 5. £437,291, Os. $3\frac{3}{2}d. \div 16\frac{3}{8}$.
- 6. 80,307 tons 16 cwt. $\div 8\frac{3}{4}$.
- 7. 1083 cwt. 110 lb. $\div 7\frac{8}{111}$.
- 8. 24 miles 3 fur. 10 po. $\div \frac{8}{147}$.

EXERCISE 11.

Miscellaneous,

- What is the cost of 186 sq. yd. of lead at 17s. 3½d. per sq. yd.?
- The price of 13 acres of land being £860, 10s., what will be the price of 16 acres?
- 3. $[£860,132, 0s. 3d. £809, 16s. 0] \times 7.$
- 4. How much will 1093 lb. of metal cost at 19s. 9d. per lb.?
- 5. 703 oz. of gold at £2, 5s. 3d. per oz.
- 6. $80\frac{1}{2}$ sq. yd. of land at $7\frac{1}{2}$ guineas per sq. yd.
- Find the weight of 84³/₂ bales of goods, each bale weighing 13 cwt. 21 lb.
- 8. 50\frac{2}{3} at £8, 10s. 6d. each.
- 9. 117 at £1, 19s. 91d. each.
- 10. 606 at £136, 17s. $7\frac{1}{2}$ d. each.
- 11. Divide 4381 tons 17 cwt. 3 qr. 14 lb. by $5\frac{1}{8}$.
- 12. Divide 9,083,909 tons by $\frac{8}{11}$.
- 13. Divide 228,134 tons 13 cwt. by $7\frac{1}{6}$.
- **14.** [£30,000, 10s. 5d. £806, 13s. $2\frac{1}{4}$ d.] × $91\frac{1}{4}$.
- 15. $[£28,011, 17s. 1d. -£6041, 19s <math>10\frac{1}{2}d.] \times 5.$
- 16. 3,289,965 yd. 1 ft. 5 in. $\times 99\frac{1}{2}$.
- 17. Find the price of copper per ton when 31\frac{3}{5} tons cost £1000.
- 18. Divide Eighteen millions and forty by one hundred and ninety-seven.
- Multiply 1700 guineas by 63¹/₂, and reduce the product to threepences.

- 20. How many farthings will pay for 177½ lb. of butter at 13¼d. per lb. ?
- 21. Multiply four hundred and sixteen thousand and ninetythree by forty thousand seven hundred, and divide the product by eleven.
- 22. Multiply nine millions and ten by sixteen thousand and eighty-one, and divide the product by one fifth of seven hundred and sixty-five.
- 23. If 81 lb. 10 oz. of sugar cost £1, how much sugar may be had for £179?
- 24. What is the cost of 180 dozen eggs at 2s. 6d. a score ?
- 25. The wages of a joiner being 91d. per hour, how much will he earn in 5 days, working nine hours a-day?

Example XI.

Find the weight of 17 bales of goods each weighing 14 cwt. 3 qr. 7 lb.

[The answer can be found by ordinary multiplication, or as below.

Here we have 17 tons = the weight at 1 ton per bale. Therefore,

since 10 cwt. $=\frac{1 \text{ ton}}{2}$ 8 tons 10 cwt. = the weight at 10 cwt. per bale. since 4 cwt. = $\frac{1 \text{ ton}}{5}$ 8 tons 8 cwt. = the weight at 4 cwt. per bale. since 2 qr. $=\frac{4 \text{ cwt.}}{8}$ 8 cwt. 2 qr. = the weight at 2 qr. per bale. since 1 qr. $=\frac{2 \text{ qr.}}{2}$ 4 cwt. 1 qr. = the weight at 1 qr. per bale. since 7 lb. $=\frac{1 \text{ qr.}}{4}$ 1 cwt. 0 qr. 7 lb. = the weight at 7 lb. per bale.

12 tons 11 cwt. 3 qr. 7 lb. = { the weight at 14 cwt. 3 qr. 7 lb. = { 7 lb. per bale.

.·. Answer =

EXERCISE 12.

[To be worked as per Example XI.]

- 1. 32 cwt. 2 qr. 21 lb. × 56.
- 2. 19 cwt. 3 qr. 17 lb. × 54.
- 3. 19,001 miles 7 fur. 101 yd. 1 ft. $6\frac{1}{2}$ in. \times 12.

4 108 leagues 1 mile 19 poles \times 3\frac{1}{2}.

- 5. What is the value of 81 times 92 tons 14 cwt. 60 lb.?
- Find the weight of 101 machines each weighing 10 cwt. 2 qr. 7 lb. 3 oz.
- 7. What is the united area of 88 plots of ground each containing 813 ac. 2 r. 17 po. 3 sq. yd. ?

8. 17½ times 803 tons 2 cwt. 10 oz.

- 9. 136 times 7 years 4 months 3 weeks 6 days.
- 10. If a wheel turn once in 2 hours 17 min. 31 sec., how long will it occupy in turning 166 times?
- Add 19 cwt. 111 lb. to 17 cwt. 3 qr. 27 lb., and multiply the result by 51.
- 12. 148 lb. 7 oz. 10 dwt. 18 gr. \times 63\frac{1}{2}.

Example XII.

What is the price of land per acre when $\frac{3}{5}$ of an acre cost £50, 7s. 6d. ?

Here $\frac{3}{5}$ acre cost £50, 7s. 6d. Therefore, $\frac{1}{5}$ acre cost $\frac{£50}{3}$ = £16, 15s. 10d.

. •. [$\frac{1}{6}$ i.e.] 1 acre costs £16, 15s. $10d \times 5 = £83$, 19s. 2d.—Answer.

EXERCISE 13.

- 1. Find the value of a ship if $\frac{3}{17}$ of it be worth £1863, 12s. 6d.
- If a man earn £16, 16s. 6d. a week, what will he earn in a
 year?
- 3. What is the price of 7 tons of coal when the price of 3 tons is £3, 10s. 6d.?
- 4. If $\frac{5}{19}$ of an acre of land be worth £145, 12s. 6d., what is the value of that land per rood?

5. How many pints would 10 barrels contain when one-fifth of the contents of a barrel is 17 pints?

6. If one-third of an acre of land be valued at £803, 10s., what will be the value of 6\frac{2}{3} acres ?

 What will be the weight of 8 trucks of coal when 1/17 of the weight of one truck is 2 tons 13 lb.?

8. Three-fourths of an acre of land are sold for £165; what is the value of that land per acre?

9. If \(\frac{3}{2} \) of a piece of land be worth 402 cows, how many cows is the whole worth?

10. What is the value of $\frac{1}{2}$ of $\frac{2}{3}$ of £5?

11. Divide £1060, 10s. $b\bar{y}$ 18 $\frac{1}{8}$.

12. 17 miles 6 fur. 17 po. 3 yd. 2 ft. 8 in. \times 75 $\frac{8}{11}$.

Example XIII:

What will be the price of $\frac{2}{3}$ acre of land when $\frac{5}{7}$ acre cost £286, 10s. ?

1st Method.

2d Method.

acre cost £286, 10s.

... 1 acre cost £286, 10s.
$$\div \frac{5}{7} = \frac{£286\frac{1}{2}}{5}$$
.

•••
$$\frac{2}{3}$$
 acre cost $\frac{£268\frac{1}{3}}{\frac{5}{3}}$ × $\frac{2}{3}$ = £267, 8s. Answer.

3d Method.

As $\frac{5}{7}$: $\frac{3}{7}$:: cost of $\frac{5}{7}$ acre: cost of $\frac{3}{7}$ acre; or, otherwise stated,

Multiplying together the extremes and the means, we get Answer × 5 = £286, 10s. × 2.

... Answer =
$$\frac{£286, 108. \times \frac{1}{5}}{£287, 88.}$$

4th Method.

[Being the 3d Method otherwise expressed.]

Multiplying across [see dotted lines], we get cost of \$ ac. × \$ = cost of \$ ac. × \$,

That is

£286, 10s.
$$\times \frac{3}{4}$$
 = Answer $\times \frac{4}{7}$.
£286, 10s. $\times \frac{3}{4}$ = Answer.
i.e., £287, 8s. = Answer

Example XIV.

In working out such sums as Example XIII, it is necessary to find the value of such a quantity as $\frac{£286, 10s. \times \frac{3}{4}}{\frac{5}{4}}$; therefore note the following working:—

$$\frac{£286, \ 10s. \times \frac{3}{2}}{\frac{5}{4}} = \frac{£286\frac{1}{2} \times \frac{3}{2}}{\frac{5}{4}} \cdot \cdot \cdot \cdot \cdot \cdot (A)$$

$$= £^{\frac{572}{2} \times \frac{3}{2}}{\frac{5}{4} \times \frac{1}{2} \times \frac{7}{2}} \cdot \cdot \cdot \cdot \cdot (B)$$

$$= £^{\frac{1337}{2} \times \frac{3}{2} \times \frac{5}{2}} \cdot \cdot \cdot \cdot \cdot (B)$$

$$= £^{\frac{1337}{5}}$$

$$= £^{267}, 8s. Answer.$$

N.B.—The expression (B) is obtained from (A), by placing the numerator of each fraction on the same side of the vinculum (i.e., the thick line) in B as the fraction itself is in A, and then placing each denominator on the side opposite to its numerator.

EXERCISE 14.

- 1. What is the value of $\frac{7}{9}$ of $5\frac{11}{14}$ of 30 times £105?
- 2. What is the value of $1\frac{6}{7}$ of $10\frac{1}{13}$ of $18\frac{1}{2}$ times $\frac{1}{3}$ of £608, 5s.?
- 3. Find the weight of a vessel \frac{1}{2} of \frac{3}{5} of whose weight is 9010 tons.

- 4. If $\frac{e}{11}$ of the value of an estate be £1839, what is the value of $\frac{e}{18}$ of the same estate?
- Find how many lbs. are equal to the weight of ⁸/₁₀ of a truck, if ⁸/₁₇ of the weight of the truck be 1 ton 110 lb.

6. The difference between \$\frac{1}{2}\$ and \$\frac{5}{11}\$ of a sum of money is \$\pmu 38\$, 2s. 6d.; what is that sum of money \$\frac{1}{2}\$

7. Simplify $\frac{3\frac{1}{2} \times 16\frac{3}{4}}{6\frac{1}{11} \times 8\frac{3}{8}}$.

8. Simplify $\frac{51\frac{5}{6} \times 7 \text{ times } 1\frac{1}{2}}{60\frac{1}{3}\frac{7}{6} \times 18 \text{ times } 1\frac{1}{10}}$.

9. Find the value of $\frac{£1060 \times 3\frac{1}{2}}{101\frac{1}{2}}$.

- 10. If half an acre of land be worth £18, 10s. 6d., what is the value of 2½ acres?
- 11. The cost of 18 miles 7 fur. of telegraph cable being £1500, what length of cable will cost £3500?
- 12. By working 8½ weeks a man earns sufficient money to purchase 1 acre 3 roods of land; how many roods of land can he purchase with the earnings of 30¾ weeks?

EXERCISE 15.

Miscellaneous.

- Take eight thousand nine hundred and nine pounds sixteen shillings and threepence from nine hundred and sixty-nine thousand and eighty-one pounds twelve shillings and tenpence farthing, and multiply the remainder by eleven.
- Subtract £808, 17s. 91d. from £909,163, 10s. 6d., and multiply the remainder by 12.
- How much must be taken from ten thousand pounds to leave eighty-three pounds sixteen and ninepence?
- 4. If 8 acres of land cost £119, 17s., what will be the cost of 16½ acres?
- 5. What weight of butter could be bought for thirty-six shillings when seven pounds cost half-a-guinea?
- If two thousand two hundred and forty pounds of coals cost £1, 13s. 4½d., what must I pay for 7 tons?

- 7. What is that sum of money which, being multiplied by 7 and then added to 7 times £80, 17s. 3½d., gives £4179, 0s. 8¾d.?
- 8. How many hogsheads of beer at £1, 5s. each cost as much as 90 hogsheads of ale at 17s. 9d. each?
- How many cows at £38, 10s. each are worth 50 horses at £48, 2s. 6d. each?
- 10. How many bushels of barley are worth 105 bushels of wheat if 7 bushels of the former are worth 3 of the latter?
- Find how many yards of calico at 3⁴/₂d. a yard are worth 220 yards of silk at 10s. 9d. a yard.
- 12. Find the cost of 206 acres at £18, 13s. 9d. per acre.
- 13. Find the cost of 727 acres at £208, 15s. 5d. per acre.
- 14. £13,829,613, 3s. $10\frac{1}{2}$ d. ÷ $7\frac{4}{7}$.
- 15. £106,038, 17s. 9\d. + 17\frac{2}{7}.
- 16. 8034 tons 17 cwt. 3 qr. ÷ 7 3
- 17. 316,827 tons 19 cwt. 3 qr. 3 oz. \div 15 $\frac{5}{8}$.
- 18. 6,631,820 tons 17 lb. 10° oz. $\div 8\frac{31}{36}$.
- 19. 29 lb. 11 oz. 13 dwt. 8 gr. \times 15 $\frac{1}{4}$.
- 20. How much iron can be bought for 10 guineas if 2 cwt. 3 qr. 12 lb. can be purchased for £1?
- 21. Find the weight of meat which can be purchased for £13 when 3 qr. 21 lb. can be bought for a sovereign.
- 22. Three cattle dealers have seven animals each to sell, and, finding the butchers will not give more than 7½d. per lb. for them, decide to kill and sell the animals themselves at 8½d. per lb. They do so, and, after paying £5 for expenses, find they have each taken £5, 15s. 10½d. more than the butchers offered them. What was the weight of each animal?
- Find the difference between the cost of a thousand sheep at nine guineas each and two hundred bullocks at nineteen guineas each.
- 24. A friend owes me £250; he offers me 10 bank notes at £5 each, 19 casks of butter at £3, 1s. 6d. each, and the rest in cash. How much shall I take from him in coin?
- 25. The weight of a waggon is one-seventh of that of the coal

it contains. If the waggon weigh 18 cwt. 3 qr. 17 lb., what will be the weight of the waggon and coal together?

- 26. A man earns twice as much as a woman; if a man's wages be £16, 8s. 9d., what will be the wages of 7 men and 41 women?
- 27. If ⁸/₁₁ of a sum of money will buy 64 acres of land, how many acres can be bought for ²/₅ of the same sum, and what will be its value at £90 per acre?

28. What is the price of 1004 tons of copper at £81\frac{1}{2} per cwt. ?

29. Multiply eight hundred and six thousand three hundred and

eighty-two by seventy thousand and ninety.

30. Take eighteen pounds six shillings and ninepence halfpenny from one thousand pounds, and find how many times eightpence halfpenny is contained in the remainder.

31. How many pairs of trousers at half-a-guinea each are worth

170 suits of clothing at 32 guineas?

32. A man's wages for one day is sufficient to pay for ? ton of coals; how many days must he work to earn money enough to pay for 108 tons 10 cwt.?

33. A man earns as much as 2 women, and his wages for a fort-night amount to £20. If the total wages of 18 men, 12 women, and 21 boys be £1240 in 4 weeks, how many boys earn as much as one man?

34. Divide ten thousand pounds among 5 men and 5 women, giving each man twice as much as a woman. What is

the share of a man and what that of a woman?

35. If ⁷/₁₈ of a sum of money will buy 85 acres of land, how much land may be bought for ⁶/₁₁ of that same sum of money?

- 36. $3\frac{1}{5}$ of $11\frac{1}{9}$ of 16 times $\frac{4\frac{3}{5}}{20\frac{1}{5}}$ of 60 guineas.
- 37. \$ of \$\frac{24}{34}\$ of 75 guineas.

38. 63 tons 7 cwt. 3 qr. $\times \frac{8\frac{1}{2}}{5\frac{1}{4}}$.

- Divide fifty guineas between A and B, giving A twice as much as B.
- 40. A horse and a donkey together cost 36 guiness; if the value of the horse be 2½ times that of the donkey, what did each cost?
- 41. How much must a gentleman leave for his son and his

daughter together, so that the daughter's share, which is $\frac{3}{4}$ of the son's, shall be £2500 \dagger

- 42. How much money will be required for A, B, and C together if A's share be \(\frac{2}{3}\) of B's, and B's share be \(\frac{1}{2}\) of C's, and C receive a thousand guineas?
- Divide £1200, 18s. 4d. between A and B, giving B three times as much as A.
- Divide £900, 9s. 8d. between A and B, giving B one-half as much as A.
- Divide £1330, 8s. 4d. between A and B, giving B one-fifth as much as A.
- 46. Divide 21 acres 2 roods of land between A and B, giving A half as much again as B.
- Divide £85, 18a 10½d. between A and B, giving B twothirds of that given to A.
- 48. How many quarter-pound packets of tea are worth 55 halfpound packets of coffee; tea being 3s. 4d. per lb., and coffee 14d. per oz.?
- coffee $1\frac{1}{2}$ d. per oz. ? 49. Simplify $\frac{4\frac{3}{8} \times 7\frac{1}{9} \times 13}{3\frac{1}{4} \times 2\frac{1}{8} \times 15}$ times $\frac{£8, 10s.}{£30.}$
- 50. Simplify $\frac{3\frac{1}{8} \times 4\frac{4}{5} \text{ of £90, 9s. 6d.}}{1\frac{3}{7} \times 1\frac{11}{13} \text{ of 5 times 17 guineas}}$

Example XV.

(Vulgar Fractions.)

Add together $3\frac{1}{2}$, $2\frac{5}{7}$, $3\frac{9}{10}$, $1\frac{11}{14}$.

Method.

- (a) Add together all the integers; thus—3+2+3+1=9.
- (b) Add together the fractions; thus—

$$\frac{1}{2} + \frac{5}{7} + \frac{9}{10} + \frac{11}{14} = \frac{35 + 50 + 63 + 55}{70} = \frac{203}{70} = 2\frac{63}{70} = 2\frac{9}{10}$$

- (c) Add together the results obtained in (a) and (b); thus— $9 + 2\frac{n}{10} = 11\frac{n}{20}$. Answer.
 - Note.—That in adding and in subtracting mixed numbers, there is no need to reduce them to improper fractions; but in multiplying and in dividing them, there is usually need to reduce them to improper fractions.

Example XVI.

Find the value of
$$\frac{16\frac{3}{4} \times 4\frac{5}{8} \times 3\frac{1}{3}}{11\frac{1}{10} \times 11\frac{1}{6} \times 7\frac{1}{7}}$$

$$\frac{16\frac{3}{4} \times 4\frac{4}{5} \times 3\frac{1}{1}}{11\frac{1}{10} \times 11\frac{1}{8} \times 7\frac{1}{7}} = \frac{\frac{47}{4} \times \frac{87}{5} \times \frac{19}{4} \times \frac{19}{5} \times$$

Note.—This method is the same as that described in Example XIV., and can be used when there is no plus or minus sign either above or below the vinculum.

Example XVII.

Find the value of $\frac{28\frac{3}{4} \text{ lb.}}{3\frac{3}{4} \text{ lb.}}$

$$\frac{28\frac{3}{4} \text{ lb.}}{3\frac{3}{4} \text{ lb.}} = \frac{\frac{115}{4} \text{ lb.}}{\frac{21}{4} \text{ lb.}} = \frac{\frac{115}{4}}{\frac{21}{4}}$$

Cancelling by 23, we now get-

$$\frac{\frac{115+23}{4}}{\frac{23+23}{7}} = \frac{\frac{5}{4}}{\frac{1}{7}} = \frac{35}{4} = 8\frac{3}{4}.$$
 Answer.

N.B.—Note here—

- That the "lb." is cancelled from the numerator and the denominator. This amounts to dividing the numerator and the denominator each by 1 lb.
- 2. That, after this cancelling, the working may be put thus—

$$\frac{115}{4} \cdot \frac{1}{23} \cdot \frac{35}{4} = 83$$

 That, counting downwards, cancelling can take place between (a) the first and third, (b) the second and fourth, of the four numbers 115, 4, 23, and 7.

EXERCISE 16.

Reduce to improper fractions—

	ouddo to impropo		******		
1.	$7\frac{8}{5}$	12.	28106	23.	726447
2.	84		2301 17	24.	2319 1 6 8
3.	6 5 11	14.	44629	25.	20017 13516
4.	$7\frac{0}{10}$	15.	803 14	26.	36927 813275 1092168
	11.8	16.	764 23		839026 19385
6.	164	17.	164		6207 4108
7 .	164	18.	1815	29.	17374 6137
8.	$23\frac{5}{12}$	· 19.	7073 205		93 628
9.	$107\frac{19}{20}$		161774087		73764196
10.	816 §	21.	237 168		88906 47041
11.	195	22.	2013 8 0 8		3,412

EXERCISE 17.

Find the least common multiple of-

- 1. 56, 21, 24, 108.
 2. 81, 63, 49, 20.
 3. 135, 60, 35, 80, 189.
 4. 102, 85, 51, 20.
 5. 105, 21, 80, 170, 27.
 11. Find the cost of 96 at 4s. 2\frac{1}{2}d. each.
- 11. Find the cost of 96 at 48. 2 d. each. 12. Find the cost of 64 at 38. $2\frac{1}{16}$ d. each.
- 13. How many articles at 1s. 7 d. each cost £2, 5s. 2 d. ?
- 14. How many articles, each weighing 95 tons 13 cwt. 2 qr. 7 lb. 8 oz., weigh in all 87,354 tons 6 cwt. 2 qr. 15 lb. 8 oz.?
- 15. From $17\frac{3}{4}$ take $15\frac{1}{9}$, and divide the remainder by $14\frac{3}{4}$.
- 16. From $2\frac{3}{7}$ times $\frac{41}{8}$ take $16\frac{1}{3}$ times $\frac{3}{49}$.

EXERCISE 18.

13.
$$8\frac{1}{2} + 6\frac{3}{4} + 17 + 4\frac{1}{11}$$

14. $\frac{7}{11} + \frac{16}{19} + 3\frac{1}{4}$
15. $2\frac{1}{4} \times 6\frac{1}{3} \times \frac{11}{190}$
16. $80\frac{3}{5} - (2\frac{1}{3} \text{ of } 16\frac{1}{7})$
17. $8\frac{1}{2} + 7\frac{3}{4} + 11\frac{1}{5}$
18. $8\frac{1}{2} + 17\frac{3}{5} + 6\frac{7}{11}$
19. $92\frac{2}{3} + 17\frac{4}{9} + \frac{17}{36}$
20. $(40\frac{4}{7} \text{ of } 50) - (3\frac{3}{8} \text{ of } 6\frac{1}{4})$

Example XVIII.

Find the value of $2\frac{1}{3} + 3\frac{3}{7}$ of $9\frac{1}{3} + 20$.

Answer =
$$2\frac{1}{8} + 3\frac{3}{7}$$
 of $9\frac{1}{8} + 20$
= $2\frac{1}{9} + \left(\frac{24}{7} \times \frac{19}{2}\right) + 20$
= $2\frac{1}{2} + 32\frac{1}{7} + 20$
= $56\frac{1}{14}$

Note.—That the signs "of," x, and ÷ connect the quantities between which they stand; but the signs + and - do not connect: thus-

$$a+b\times c-d+f\div e=a+(b\times c)-d+(f+e)$$

EXERCISE 19.

- 1. Find the least common multiple of 72, 180, 20, 32.
- 2. Find the least common multiple of 90, 36, 27, 25.
- 3. Find the least common multiple of 88, 121, 132, 143. 16. $\frac{5}{9} + 8\frac{2}{9} + 16\frac{31}{38} + \frac{19}{61}$

4.
$$\frac{8}{5} + \frac{7}{16} + \frac{15}{32}$$
5. $\frac{19}{27} + \frac{35}{54} + \frac{23}{36} + \frac{4}{5}$
6. $\frac{2}{37} + \frac{35}{54} + \frac{23}{36} + \frac{4}{5}$
7. $\frac{7}{13} + \frac{38}{36} + \frac{106}{143}$
8. $\frac{3}{6} + \frac{17}{36} + \frac{106}{24}$
9. $\frac{7}{8} + \frac{8}{9} + \frac{10}{36}$
10. $\frac{24}{5} + \frac{23}{68} + \frac{17}{102} + \frac{61}{36}$
11. $\frac{45}{61} + \frac{38}{36} + \frac{67}{102} + \frac{6}{3}$
12. $\frac{117}{117} + \frac{41}{143} + \frac{17}{124} + \frac{36}{36}$
13. $\frac{3}{7} + \frac{5}{8} + \frac{17}{12} + \frac{23}{24}$
14. $8\frac{6}{7} + 9\frac{13}{36} + 8\frac{8}{81} + 19\frac{7}{102}$

15. $\frac{8}{11} + 3\frac{2}{5} + 6\frac{24}{35} + 2\frac{3}{14}$

24.
$$\frac{4\frac{1}{19} + 3\frac{1}{2}\frac{9}{1} + 3\frac{1}{2}\frac{9}{1}}{8\frac{3}{11} - 2\frac{4}{17}}$$

EXERCISE 20.

1.
$$\frac{3}{7} + \frac{5}{8} + \frac{18}{28} + \frac{23}{84}$$
2. $\frac{3}{17} + \frac{14}{36} + \frac{81}{85} + \frac{63}{85}$
3. $\frac{4}{5} + \frac{18}{91} + \frac{36}{675} + \frac{251}{650}$
4. $3\frac{2}{8}$ of $4\frac{2}{7}$ of $101\frac{1}{9}$
5. $3\frac{1}{8}$ of $4\frac{1}{7}$ of $6\frac{1}{2}$
6. $3\frac{4}{9} + 17\frac{5}{6} + 31\frac{5}{8}$
11. $21\frac{13}{20} - 3\frac{16}{45}$
12. $16\frac{23}{45} - 12\frac{8}{17}$
13. $15 \times 18 \div 2\frac{1}{2} + 11\frac{1}{2} - 3\frac{1}{8} \times 2\frac{1}{7} \times 1\frac{1}{8}$
14. $7 \times 8 - 3 + 5 \div 2 + 3 \times 8 - 10 \times 7$
15. $2\frac{1}{2} \times 4\frac{3}{5} + 8\frac{1}{2} - 2\frac{1}{8} + 6\frac{1}{2} \div 5\frac{1}{5}$
16. $\frac{7}{13} + \frac{5}{6} \times \frac{1}{10} + \frac{5}{8}$ of $\frac{3}{8}$
17. $\frac{28\frac{1}{2} + 17\frac{4}{5} + \frac{8}{11}}{2\frac{1}{2}}$
18. $5\frac{5}{8} \times 10\frac{4}{9} \times \frac{10}{23\frac{1}{2}}$
19. $\frac{16\frac{1}{6} - 13\frac{5}{8}}{10}$
20. $\frac{13\frac{3}{4} \times 7\frac{1}{8}}{1\frac{7}{17}}$
21. $\frac{2\frac{1}{3} \times 4\frac{3}{4} \times 10}{7\frac{1}{6} + 6\frac{1}{9}}$
22. $\frac{3\frac{3}{6} + 18\frac{4}{6} + 7}{21\frac{1}{2} \times 3\frac{3}{4} \times 8}$
24. $\frac{3\frac{1}{2} + 8\frac{1}{2} + 10\frac{3}{5}}{7 + 7\frac{1}{2} + 17\frac{3}{5}}$
25. $\frac{20\frac{4}{5} \times 3\frac{7}{10}}{2\frac{5}{8} \times 17}$ times $1\frac{3}{8}$ of 16 times 100 crowns

EXERCISE 21.

HARMOIDE 21.								
1.	$3\frac{1}{8} \times 7\frac{3}{40} \times 2\frac{1}{2}$	7.	$27\frac{8}{9} - 17\frac{8}{11}$					
2.	$6\frac{3}{4} \times 18\frac{5}{5} \times 2\frac{3}{4}$	8,	$30\frac{14}{18} - 12\frac{29}{88}$					
3.	183 - 25		$61\frac{23}{43} - 38\frac{7}{80}$					
4.	17§ - 11§	10.	$4\frac{2}{8} \times 8\frac{2}{5} \times \frac{165}{490} \times \frac{17}{860}$					
5 .	$17\frac{7}{8} - 11\frac{2}{8}$	11.	$3\frac{3}{8}$ of $8\frac{1}{2}$ of $3\frac{3}{84}$ of $6\frac{3}{4}$					
6.	$82\frac{5}{11} - 33\frac{2}{9}$	12.	$21\frac{8}{11}$ of $8\frac{5}{9}$ of $17\frac{8}{13} \times 1\frac{17}{2}$					
13.	$8\frac{2}{7} \times \frac{113}{290} \times \frac{77}{106} \times \frac{588}{990} \times$							
14.	$2\frac{3}{8} + 4\frac{3}{8}$ of $1\frac{1}{7}$ of $\frac{13}{24} + 16$	5.						
	$2\frac{4}{8}$ of $1\frac{7}{8}$ of 18 times 16.	-	•					
16.	8 of 41 times 17 times 2 3	of 10	•					

17. $8\frac{1}{5} + 2\frac{4}{7} + \frac{21}{35}$ of $7\frac{6}{7}$.

18.
$$11\frac{3}{7}$$
 of $21\frac{7}{100}$ of $5\frac{5}{11}$ of $9\frac{3}{7}$. | 22. $2\frac{3}{7}$ of $\frac{61}{340} - 1\frac{3}{4}$ of $\frac{1}{2}$ of $\frac{81}{560}$.

20.
$$28\frac{3}{4}$$
 of $7\frac{5}{23} + 6\frac{3}{8} - 2\frac{3}{8}$.

19.
$$81\frac{3}{4} - \frac{3}{6}$$
 of $26\frac{1}{4}$.
20. $28\frac{3}{4}$ of $7\frac{5}{23} + 6\frac{5}{6} - 2\frac{3}{6}$.
21. $\frac{6\frac{3}{6}}{11\frac{5}{11}}$ of 7 times $\frac{3}{8}$ of £100.
22. $\frac{20\frac{3}{8} \times 2\frac{3}{16}}{8\frac{1}{2} + 20\frac{7}{7} - \frac{5}{11}}$ of $\frac{210\frac{3}{8}}{100}$

25.
$$\frac{4}{13} + \frac{7}{12} + \frac{5}{9} \div \frac{5\frac{1}{6}}{7\frac{1}{3}} \times 6\frac{1}{3} \times 7\frac{1}{4}$$
.

EXERCISE 22.

Reduce the following to Vulgar Fractions:-

1.
$$\frac{3\frac{4}{8}}{8\frac{3}{8}}$$

5.
$$\frac{\frac{28}{7\frac{5}{18}}}{21\frac{8}{18}}$$

9.
$$\frac{23}{81}$$

13.
$$\frac{3\frac{17}{20}}{2\frac{13}{30}}$$

2.
$$\frac{7\frac{4}{11}}{6\frac{3}{7}}$$

10.
$$\frac{19\frac{1}{2}}{6\frac{5}{7}}$$

14.
$$\frac{4\frac{17}{24}}{5\frac{18}{48}}$$

$$3. \frac{3}{9\frac{7}{12}}$$

7.
$$\frac{8\frac{3}{4}}{6\frac{7}{12}}$$

$$10.\frac{7}{10.7}$$
 $10.17\frac{3}{4}$

15.
$$\frac{2\frac{7}{8}}{8\frac{3}{11}}$$

$$21.\ \frac{4\frac{1}{2}+6}{2\frac{3}{5}+4}$$

$$8\frac{1}{10} \times 64 \times 3$$
18.
$$\frac{2\frac{1}{2} \times 4\frac{4}{5} \times 8\frac{2}{3}}{8^{\frac{1}{3}} \times 8^{\frac{1}{3}}}$$

22.
$$\frac{3\frac{8}{8} - 1\frac{7}{9}}{24\frac{17}{19} - 16\frac{13}{8}}$$

19.
$$\frac{8\frac{4}{5} \times 2\frac{3}{7} \times 6\frac{2}{3}}{5\frac{5}{5} \times 7\frac{7}{7} \times 6\frac{3}{5}}$$

17.
$$\frac{8\frac{13}{11} \times 15 \times 2\frac{5}{11}}{8\frac{1}{10} \times 64 \times 3\frac{7}{7}}$$
18.
$$\frac{2\frac{1}{2} \times 4\frac{4}{5} \times 8\frac{3}{3}}{3\frac{7}{7} \times 2\frac{4}{13} \times 6\frac{7}{17}}$$
19.
$$\frac{8\frac{4}{5} \times 2\frac{7}{7} \times 6\frac{3}{5}}{5\frac{7}{7} \times 7\frac{7}{11} \times 6\frac{3}{5}}$$
21.
$$\frac{4\frac{1}{2} + 6\frac{3}{5} + 7\frac{1}{4}}{2\frac{2}{5} + 4\frac{5}{5} + 1\frac{1}{2}}$$
22.
$$\frac{3\frac{8}{5} - 1\frac{7}{9}}{24\frac{17}{5} - 16\frac{13}{27}}$$
23.
$$\frac{4\frac{1}{2} - \frac{1}{3}}{4} \times \frac{3}{5} \times 1\frac{1}{8} \times 1\frac{1}{5} + 8$$
24. Divide \$601 by \$3 of 7 of

20.
$$\frac{19\frac{1}{2} - 4\frac{5}{21}}{16\frac{3}{7} - 11\frac{4}{11}}$$

25. Divide £328 by \$ of 4 of £122, 2s.

EXERCISE 23.

1.
$$\frac{7}{8}$$
 of $\frac{16}{35}$ of $\frac{5}{9}$ of £2, 5s.
2. $4\frac{3}{7} + \frac{2}{8} + 1\frac{1}{8} + 4\frac{5}{9}$
4. $31 + 87 - 2\frac{5}{9}$

2.
$$4\frac{3}{7} + \frac{2}{5} + 1\frac{1}{6} + 4\frac{5}{6}$$

3.
$$\frac{17\frac{3}{11}-6\frac{4}{5}}{18-13\frac{3}{5}}$$

5.
$$7\frac{1}{2} \times 3\frac{1}{2} + 15\frac{1}{4} - 2\frac{5}{8} \div 1\frac{3}{7} \times 21$$

15. $8\frac{1}{2} \times 17\frac{1}{3} \times 2\frac{3}{3}$

16. $25\frac{3}{4} \times \frac{4}{11} \times 17\frac{1}{2}$

6.
$$6\frac{5}{12}$$
 of $13\frac{5}{7}$ of $1\frac{31}{53}$ of $1\frac{75}{81}$

7.
$$2\frac{1}{3} + 1\frac{3}{8} + 7\frac{1}{2}$$

3.
$$2\frac{1}{2} + 3\frac{5}{8} + 11\frac{7}{11}$$

9.
$$15\frac{3}{4} + 18\frac{1}{2} + 17\frac{3}{8}$$

11.
$$2\frac{3}{4} + 17\frac{1}{3} + 6\frac{4}{11} + 2\frac{1}{88}$$

12.
$$\frac{2\frac{5}{8} - \frac{3}{4}}{3\frac{7}{9} - 2\frac{1}{4}}$$

7.
$$2\frac{1}{3} + 1\frac{1}{8} + 7\frac{1}{2}$$
8. $2\frac{1}{2} + 3\frac{5}{8} + 11\frac{7}{11}$
9. $15\frac{3}{4} + 18\frac{1}{2} + 17\frac{5}{8}$
10. $15\frac{5}{8} - 4\frac{7}{11}$
11. $2\frac{3}{4} + 17\frac{1}{3} + 6\frac{4}{11} + 2\frac{1}{88}$
12. $2\frac{5}{8} - \frac{3}{4}$
13. $\frac{18\frac{1}{2} + 16\frac{3}{8} + 4\frac{1}{8}}{2\frac{1}{4} + 3\frac{5}{9} + 18\frac{11}{12}}$
14. $\frac{3\frac{1}{2} \times 7\frac{2}{3} \times 11}{4\frac{3}{4} \times 4\frac{2}{5} \times 7}$
65 tons 3 cwt.

16. $25\frac{3}{4} \times \frac{41}{1} \times 17\frac{1}{2}$
17. $2\frac{1}{2} + 8\frac{3}{7} + 10\frac{4}{8}$
18. $3\frac{4}{5} - 1\frac{1}{16}$
19. $\frac{2\frac{1}{8} \times 18\frac{5}{7} \times 10\frac{8}{8}}{2\frac{1}{11} \times 1\frac{1}{4}}$
20. $\frac{21\frac{1}{3} \times 18\frac{5}{7} \times 10\frac{8}{8}}{21 \times 16\frac{8}{8}}$
21. $\frac{18\frac{1}{3} - 7\frac{4}{5}}{10\frac{3}{4} - 2\frac{5}{7}}$
22. $11\frac{1}{7} - 7\frac{1}{17}$
23. $3\frac{3}{8} + 4\frac{4}{7} + \frac{13}{28}$

14.
$$\frac{3\frac{1}{2} \times 7\frac{2}{3} \times 11}{4\frac{2}{3} \times 4\frac{2}{5} \times 7}$$

24. Multiply
$$\frac{65 \text{ tons } 3 \text{ cwt.}}{80 \text{ tons } 7 \text{ cwt.}}$$
 by $\frac{£11, 10s.}{£17, 5s.}$

 $\frac{5}{13}$ of 11 times $1\frac{5}{7}$ of 1000 $\frac{17}{19}$ of 15 times $\frac{3}{5}$ of $\frac{50}{400}$ of $2\frac{1}{2}$ times 25

Exercise 24.

_				
	$2\frac{5}{8} \times 12$	6.	8_{20}	× 12
	$7\frac{4}{9} \times 15$			× 33
3.	$8\frac{7}{12} \times 20$	8.	7 5	× 8
4.	$6\frac{5}{6} \times 8$			× 50
5.	$7\frac{4}{15} \times 12$	10.	74	× 50
10	£809, 19s. 9d. ×	24		-
16.	100		. 1	21.
	£70, 17s. 6d. × 3	1 × 2	1	
17.	100		~	22.
	$3\frac{4}{9} + 8\frac{7}{19}$			
18.	$\frac{3\frac{4}{9} + 8\frac{7}{12}}{6\frac{1}{2} + 8\frac{3}{8}}$			23.
10	292			
	$10\frac{1}{2} - 4\frac{3}{4}$			24.
			- 1	
20.	$\frac{7\frac{4}{7}-3\frac{3}{8}}{6\frac{2}{3}+4\frac{5}{8}}$		- 1	25.
	Ug + #8	•	ı	

Example XIX.

Find the cost of 16 tons 8 cwt. at £1, 5s. per ton.

Here 16 tons 8 cwt. = 16 $\frac{1}{2}$ tons. And £1, 5s. = £1 $\frac{1}{2}$.

: Answer = £1\frac{1}{2} \times 16\frac{2}{3} = £\frac{1}{2} \times \frac{1}{2} \frac{1}{2} = £20, 10a.

EXERCISE 25.

Find the cost of-

- 1. 6 tons 10 cwt. at 18s. 6d. per ton.
- 2. 18 tons 18 cwt. at £1, 5s. per ton.
- 3. 10 tons 15 cwt. at £1, 9s. 6d. per ton.
- 4. 6 tons 15 cwt. at £436 per ton.
- 5. 7 tons 15 cwt. at £11, 9s. 6d. per cwt.
- 6. 8 tons 15 cwt. at £13, 5s. 8d. per cwt.
- 7. 10 tons 10 cwt. at 17s. 9d. per ton.
- 8. 13 tons 10 cwt. at 19s. 10d. per ton.
- 9. 16 tons 12 cwt. at 15s. 10d. per ton.
- 10. 23 tons 16 cwt. at £1, 3s. 2d. per ton.
- 11. 2 tons 10 cwt. at 1s. 11d. per cwt.
- 12. 7 tons 16 cwt. at £25, 13s. 8d. per ton.
- 13. 7 tons 17 cwt. at 5s. 8d. per ton.
- 14. 10 oz. 11 dwt. 13 gr. at 6s. 4d. per oz.
- 15. 8 tons 17 cwt. at 9s. 4d. per ton.
- 16. 13 tons 11 cwt. at 17s. 3d. per ton.
- 17. 8 tons 17 cwt. 3 qr. 14 lb. at £6, 8s. 4d. per ton.
- 18. 10 tons 14 cwt. at 19s. 2d. per ton.
- 19. 17 tons 18 cwt. 2 qr. at 19s. 3d. per ton.
- 20. 21 tons 19 cwt. 3 qr. at £1, 16s. 4d. per ton.
- 21. 18 tons 17 cwt. 3 qr. at £16, 5s. 5d. per ton.
- 22. 16 tons 13 cwt. 3 qr. at £91, 17s. 8d. per ton.
- 23. 16 tons 17 cwt. 1 qr. at 15s. 3½d. per cwt.
- 24. 22 yd. 1 ft. 9 in. at 16s. 9d. per yard.
- 25. 17 yd. 1 ft. 9 in. at 18s. 4d. per yard.

Exercise 26.

Miscellaneous.

- 1. If the value of \(\begin{aligned}
 \text{ be £717, 10s., what will be the value}
 \end{aligned} of 3?
- 2. If 11 men earn £80, 17s., what will 19 men earn in 3 times as long?
- 3. £85, 17s. $7\frac{1}{2}$ d. × $9\frac{1}{2}$. 4. £405, 15s. 2d. \times 12\frac{1}{2}. $20 \times 63 \times 21 \times 33 \times 55 \times 112$
- $99 \times 30 \times 5 \times 77 \times 128 \times 4.$
- $54 \times 70 \times 12 \times 64 \times 63 \times 121 \times 44$
- $132 \times 63 \times 72 \times 15 \times 28 \times 88 \times 49.$
- 7. Find the least common multiple of 27 and 75.
- 8. Find the least common multiple of 52 and 65.
- 9. Find the least common multiple of 280 and 960.
- Find the least common multiple of 312 and 640.
- 11. 16 tons 14 cwt. 3 qr. 6 lb. \times 7½.
- 12. 109 oz. 18 dwt. 19 gr. $\times 4\frac{1}{4}$.
- 13. 19 cwt. 3 qr. 17 lb. 6 oz. $\times 8\frac{1}{2}$
- 14. 640 miles 5 fur. 30 poles \times 101.
- 15. 601 tons 17 cwt. 101 lb. \times 16\frac{3}{2}.
- 16. $86\frac{2}{7} 20\frac{7}{6}$.
- 17. $17\frac{2}{5} 10\frac{6}{19}$
- 20. What is the cost of 108 yd. of silk at 17s. 5d. per yd.?
- 21. What is the cost of 83 yd. of calico at 9½d. per yd.?
- 22. $11\frac{2}{3} 4\frac{3}{10}$
- 23. $80\frac{11}{40} 20\frac{6}{7}$
- 24. $6\frac{3}{5}$ of $8\frac{7}{11}$ of $17\frac{3}{16}$ of 41
- 25. $8\frac{1}{2} + 17\frac{2}{5} + 6\frac{7}{11}$
- 26. $62\frac{1}{2} \times 3\frac{1}{7} 6$ times $18\frac{3}{8}$
- 27. $\frac{166 \text{ times } 5\frac{3}{83} \times 2\frac{1}{54}}{3\frac{1}{8} \text{ times } \frac{1}{7}\frac{1}{14} \times \frac{180}{80}}$
- 28. $\frac{1}{21\frac{1}{6}+17\frac{3}{7}}$
- 35. $80\frac{21}{44} 3\frac{5}{7}$ of $1\frac{1}{39}$ of $16\frac{2}{8}$

18. $3\frac{3}{5} + 8\frac{3}{5} + 10$ 19. $2\frac{1}{9} + 3\frac{1}{9} + 6\frac{3}{8}$

- 30. $100-2\frac{1}{8}$ of 15

- 32. $21\frac{3}{4} + \frac{5\frac{1}{2}}{6\frac{3}{4}}$ of 80 33. $29\frac{4}{5}$ of $8\frac{7}{10} 2\frac{1}{5}$ of $18 \times \frac{1}{12}$

- Find the cost of 108 sq. yd. of lead at £1, 19s. 9d. per sq. yd.
- 37. Find the cost of 83 tons 10 cwt. at £33, 10s. per ton.
- 38. Find the cost of $29\frac{1}{4}$ tons at £121, 10s. per ton.
- 39. Find the cost of 171 barrels of oysters at £2, 5s. a barrel.
- 40. Find the cost of 103 ac. 2 r. at £827, 2s. 6d. per acre.
- 41. Divide a thousand and one miles by 89½, and express the quotient in inches.
- 42. 16 miles 3 fur. 21 po. 2 yds \div 81 $\frac{1}{8}$.
- 43. 71 tons 13 cwt. 1 qr. 19 lb. ÷ 85 §.
- 44. 201 miles 7 fur. 3 po. 2 yd. 3 in $\div 91\frac{3}{7}$.
- 45. 1001 miles 3 yd. 1 ft. 5 in. ÷ 21 3.
- 46. Multiply the sum of $101\frac{1}{2}$ and $66\frac{5}{11}$ by their difference.
- 47. $\frac{\frac{4}{13}8. \div \frac{1}{3}}{\frac{6}{17} \times \frac{3}{4}} \times 1\frac{1}{3}$; reduce the result to the fraction of £1.
- 48. $101\frac{3}{17} \frac{2\frac{1}{2}}{3\frac{3}{4}}$ of 15 times $\frac{81}{6\frac{3}{4}} \times 10$.
- 49. $\frac{77 \text{ times } \frac{13}{14} \text{ of } \frac{15}{16} \text{ of } 19 \text{ guineas.}}{39 \text{ times } \frac{3}{8} \text{ of } 1\frac{1}{8} \text{ of } 38 \text{ shillings.}} | 50. \frac{91\frac{1}{9} 60\frac{3}{8} 76\frac{3}{8}}{28\frac{1}{9} 20\frac{4}{8} 17\frac{3}{3}\frac{1}{2}}$

EXERCISE 27.

Decimal Fractions.

Convert the following to decimals:-

16. Reduce $\frac{76}{60}$ and $\frac{5}{18}$ to decimals; take the less from the greater, and multiply the remainder by 14.85.

- 17. Increase 16.65 by 3 times itself, and divide the result by 18 times the difference between 1½ and 1.45.
- Reduce 16.5 by 4 times ½ of itself, and multiply the remainder by .0003.

Example XX.

Reduce $\frac{11}{31}$ to a decimal.

31) 110 (·3548387 93 17 774 &c., &c., &c. 193 548, &c. Note.—The remainder opposite B is 3; that opposite A is 12; i.e., the remainder opposite B is ½ of that opposite A. But the figures produced in the quotient by the remainder 12 are 387 &c. Therefore the figures which will be produced by the remainder 3 will be ½ of 387 &c., and may, therefore be found by dividing 387 &c. by 4; we thus find that the value of the "&c." in the quotient may be found by commencing to divide by 4 at the 3 over the letter C, and placing the figures of the quotient so found after the 7 over the letter D, and then continuing to divide till the figures are found to repeat, as shown below:—

or, written out in one line, we get-

EXERCISE 28.

Reduce to decimals:-

1. $\frac{40\frac{3}{4}}{185}$	7. $\frac{5\frac{5}{16} \text{ of } 11}{8\frac{5}{11} \text{ of } 12\frac{1}{7}}$	13. $\frac{92}{8.25}$	19. $\frac{113}{231}$	
2. $\frac{23\frac{1}{2}}{31}$	8. 2 ² / ₅ + 4 ⁴ / ₇	14. $\frac{85\frac{2}{3}}{100\frac{3}{7}}$	20. $\frac{3\frac{3}{4}}{18\frac{1}{2}}$	
3. $3\frac{2\frac{1}{2}\times7}{3\frac{1}{3}\times13}$	9. $\frac{30\frac{3}{7}}{27}$	15. $\frac{13}{14}$	21. $\frac{2\frac{1}{2} \text{ of } 11\frac{3}{4}}{7\frac{1}{8} \text{ of } 8\frac{1}{2}}$	
4. $\frac{28\frac{3}{4}}{7\frac{1}{4}}$	10. $\frac{29}{104}$	16. $\frac{2\frac{1}{8}}{8\frac{1}{7}}$	22. $\frac{3\frac{1}{2}}{7\frac{1}{4}}$	
5. $\frac{3\frac{1}{8}}{6\frac{2}{8}}$	11. $\frac{51\cdot 4}{12\frac{1}{7}}$	17. $\frac{15\frac{1}{4}}{16\frac{1}{4}}$	23. $\frac{16\frac{4}{5} \text{ of } 5\frac{5}{12}}{19\frac{3}{4} \text{ of } 2\frac{1}{7}}$	
6. $\frac{3\frac{1}{8}}{4\frac{1}{6}}$	12. $\frac{53\frac{1}{2}}{27.5}$	18. $\frac{107}{910}$	24 . $\frac{71}{102}$	
25. $\frac{80\frac{1}{4}}{16\frac{3}{4}}$				

EXERCISE 29.

Reduce the following quantities to decimals:-

7.
$$\frac{15}{22}$$
 | 8. $\frac{1\cdot 5}{2\cdot 55}$ | 9. $\frac{17\frac{1}{2} + 8\frac{3}{4} + 20}{3\frac{1}{2}}$ | 10. $\frac{13 + 16 + 18}{15 \times 1\frac{1}{2} \times 17}$

Reduce the following quantities to vulgar fractions:-

25.
$$\pounds 7\frac{1}{8}$$
 $\pounds 20, 16s. 3d.$

Example XXI.

Reduce 80063 to an improper vulgar fraction.

First Method.

$$0063 = \frac{63}{9990} = \frac{7}{1110}$$

Therefore $8.0068 = 8_{1110} = \frac{8887}{1110}$ Answer.

Second Method.

$$8.0063 = \frac{80063 - 80}{9990} = \frac{79983}{9990} = \frac{8887}{1110} Answer.$$

Example XXII.

Reduce $\frac{4.27}{.49}$ to a rulgar fraction.

The student will here notice that the number of decimal "places" in the numerator is the same as in the denominator, viz., two; in such cases the decimal points may be disregarded.

Therefore
$$\frac{4.27}{.49} = \frac{427}{49} = \frac{61}{7}$$
.

Example XXIII.

Reduce
$$\frac{7.5 \times 3.28 \times 4.25 \times 2.1}{.17 \times 1.05 \times .9 \times 8.2}$$
 to a decimal number.

The total number of decimal "places" in the numerator here is six; the number in the denominator is also six; therefore the decimal points may be disregarded, and the

Answer =
$$\frac{75 \times 328 \times 425 \times 21}{17 \times 105 \times 9 \times 82} = \frac{500}{3} = 166 \cdot 6$$
.

Example XXIV. Reduce
$$\frac{013}{6.5}$$
 to a decimal.

The number of "places" in the numerator in this case is not the same as that in the denominator, but the numbers of the "places" can be made equal, thus-

$$\frac{.013}{6.5} = \frac{.013}{6.500} = \frac{.013}{6500} = \frac{.13}{6500} = .002$$
 Answer.

Example XXV.

Divide 8.3 by 7.8.

Answer =
$$\frac{8\cdot3}{7\cdot8} = \frac{7}{18} = \frac{25}{18} \times \frac{10}{100} = \frac{125}{117} = 1.068376$$
.

N.B.—In the quantity $\frac{8\cdot3}{7\cdot8}$ the number of decimal places in the numerator is the same as in the denominator, but the method used in Examples XXII. and XXIII. may not be applied here because one of the decimals recurs.

EXERCISE 30.

Find, to not more than ten places of decimals, the values of the following quantities:—

	0 1				
	81.63 × 7.819		$30\frac{3}{4} \times 81$	10	12s. 6d.
2.	106.39×25.82	9.	$\frac{304 \times 61}{17\frac{7}{8} \times 46}$	18.	17s. 6d.
3.	82.9	10.	3·82 × 6·7	19.	17s. 9½d.
Э.	63.7	,,	$\frac{2\frac{1}{4}}{1.04}$	10.	£3, 6s.
	7.1	11.	1.04	20.	530·0183
4.	8.2		20·705 × 3·82	20.	720.9
E	2.03×6.89	1	82.835×12.7	21.	103 3
Э.	$\frac{200\times 600}{4\cdot 05\times 8\cdot 72}$	14.	4.0572×6.605	41.	1094
0	7.74×6.7	15.	2.70707	22.	·0163
0.	$\overline{12.3\times9.81}$	15.	·013	22.	0.0114
77	$\frac{5\frac{1}{4}}{3\frac{1}{7}}$	16.	218.09	23.	10006
ι.	$\overline{3\frac{1}{7}}$	10.	63.5	23.	918161
	$\frac{8\frac{3}{4}}{7\frac{1}{8}}$	17.	91.91	24.	£1, 0s. 3d.
0.	$7\frac{1}{8}$	1	707·6	27.	£8, 8s.
25. 13s. 7d.					
$\frac{1}{1}$ guinea					

EXERCISE 31.

- 1. Reduce 12s. 7d. to the decimal of £1, 10s.
- 2. Reduce $6\frac{1}{2}$ guineas to the decimal of £22, 1s.
- 3. Reduce 5 yd. 2 ft. 7 in. to the decimal of 10 yd. 9 in.
- 4. Reduce $2\frac{1}{4}$ times 6s. 6d. to the decimal of $3\frac{1}{4}$ times 4s. 4d.

Find the value of—

- 5. 86.35 of 10 tons
- 6. 273.45 of a £10 note
- 7. 63·375 of £20
- 8. 109.8675 of 38 yds.
- 9. 26.3875 of 91 miles
- 10. 28.965 of £8

- 11. 713.59 of 3 tons
- 12. 53.787 of 32 cwt
- 13. 99 99 of 10 guineas 14. 260 07 of 81 yds. 15. 3 65 of £20, 10s.
- 16. 8.89 of £36, 10s.
- 17. Reduce $\frac{3\frac{1}{7} \times 17 \times 10\frac{4}{5}}{1\frac{2}{7} \times 6\frac{3}{8} \times 10}$ to a decimal number.
- $\frac{2.5 \times 18.6 \times 17.83}{23\frac{1}{4} 19\frac{3}{7}}$ to a decimal number.
- 19. 6380.014×2.45 .
- 20. To 18.8 add $\frac{1}{3}$ of itself and find what decimal number must be taken from the result to leave ? of that result.
- 21. Find the value of $18.65 \times 2.5 \times 3.3$.
- 22. Add together 20.6; 13.08; 14.629.
- 23. Reduce 016 to a vulgar fraction.
- 24. Multiply $86\frac{2}{8}$ by $4\frac{1}{5}$ and reduce the product to the decimal of 20 times $\frac{3}{5}$ of 8.
- 25. Reduce $\frac{4.62 \times 7.8}{9.3 \times 8.25}$ to a decimal.

EXERCISE 32.

- 1. 20.038×71.06
- **2.** 400.807×90.908
- 3. 20306.7×1.00109
- 4. 483062×20.007
- **5.** 80·3 20·5
- 6. .75 + .45 + .7
- 7. $11.5 \div 18.75$
- 8. $86.009 \times 3\frac{1}{9}$
- 9. $83.2067 \times 8\frac{1}{3}$
- 10. 55·007 × ·0138
- 21. From £2000 take 065 of 1300 guineas.

- 11. $\frac{23\frac{1}{3} + 4.5 16.7}{10.375 4\frac{3}{8}}$
- 12. 0608 + 17.009 + 00036
- 13. 91.007×18.85
- 14. 91 093 × 80·5
- 15. 3.75 + 18.2 + 1.3
- 16. $8.75 \times 4.142857 \times 13$
 - 17. 2.5 + 8.27 + 17.8
 - $\frac{3\cdot3\times4\cdot5}{10\cdot5\times8}$
- 19. 2.5 + 8.5 + 17.36
- **20.** 17.4063×21.08

- 22. Reduce $\frac{3s. 1\frac{1}{2}d.}{4s. 6d.}$ to a decimal.
- 23. Multiply 45.618 by 20.45.
- 24. $\frac{180.25 \times 000625}{71}$ to seven places of decimals.
- 25. If a piece of lead 13 ft. long, 2½ ft. wide, and 1½ in. thick, be rolled out to cover a space 20 ft. square, express its thickness in decimals of an inch.

Exercise 33.

Miscellaneous.

1. £13, 7s. 2½d. × 24	5. £71, 3s. $6\frac{1}{2}$ d. $\div \frac{1}{51}$
2. £40, 6s. 41d. × 4.75	6. £12218, 8s. 4d. × 17
3. £108, 14s. 3d. ÷ 3⋅5	7. $4\frac{9}{7} \times 18\frac{1}{5} \times \frac{1}{15}$
4. £86603, 4s. 4d. $\times \frac{1}{26}$	8. 18 tons 15 cwt. 3 qr. $\div 2\frac{1}{3}$
9. 21 tons 16 cwt. 2 gr. 12	lb. ÷ 1 2 .

- 10. 25 tons 4 cwt. 1 qr. 6 lb. 2 oz. \div 1·3.
- 11. 8 miles 7 fur. 32 po. ÷ ·136.
- 12. $17 \times 18 13 + 20 + 12\frac{1}{2} \times 3 \div 4$ to a decimal number.
- 13. Reduce 00205 to a vulgar fraction.
- 14. Reduce 47.72 to an improper vulgar fraction.
- 15. Reduce 200 05205 to an improper vulgar fraction.

16.
$$21 \cdot 375 - 14 \cdot 83$$
 17. $\frac{20 \cdot 5 \times 4 \cdot 83}{18 \cdot 5}$

- 18. Find the cost of 4.4 tons at £0.375 per quarter.
- 19. Find the cost of 838 yds. of cloth at £0.675 per yd.
- 20. Multiply £10, 6s. 4\frac{1}{2}d. by 5 of 17.5.
- 21. Express $\frac{1.7}{28.9}$ as a vulgar fraction.
- 22. Express $\frac{7}{8}$ as a decimal fraction.
- 23. By what decimal number must $18\frac{3}{4}$ be multiplied to give $15\frac{5}{8}$?
- 24. By what mixed number must 913 be divided to give 161?
- 25. Reduce £86, 10s. 1½d. to the decimal of £100.

26. Reduce 23s. to the decimal of a guinea.

27. Find the cost of 86 tons 17 cwt. 2 qr. at £5, 9s. 6d. per ton.

28. Reduce $\frac{3\frac{1}{3} \times 7\frac{1}{2} \times 9}{10 \times 21 \times 18\frac{1}{3}}$ of $\frac{£3, 10s}{£11}$ to a decimal fraction.

29. A snail crawls up a tree 3 ft. daily and falls down 2 ft. nightly; on what day will it reach the top, supposing the tree to be 21 ft. high?

30. How many envelopes, each 7 in. long and 3½ in. wide, will exactly cover the floor of a room which is 13 ft.

long and 10 ft. 6 in. wide?

31. How many books, each 14 in. long, 5½ in. wide, and 1¾ in. thick, will just fill a box which is 2 ft. 3½ in. deep, 5 ft. 10 in. wide, and 7 ft. long? and in what position in the box must the books be packed so as to lose no space?

32. If oranges be advertised at 5s. per hundred, how many oranges will actually be bought for £6, 10s. if they be counted at the rate of 6 score to the hundred?

33. How many horses can eat as much grass in 16 days as 80

horses can consume in 30 days?

34. A lady goes to shop with £20 in her pocket. She buys 12 lb. of sugar at 3\frac{2}{3}d. per lb., 5 lb. of tea at 3s. 4d. per lb., 6 tons of coal at £1, 6s. 6d. per ton, and also pays £5, 10s. for the silk of a new dress. How much money does she bring back with her?

35. If a package be carried 193 miles for £3, 8s. 3d., how many miles ought it to be carried for £8, 10s. 7½d.?

36. A waggon weighs 17 cwt. 3 qr. 11 lb., and the coal in it is 5 times as heavy as the waggon itself; what is the weight of the waggon and the coal together?

37. Divide 2022 tons 13 cwt. 100 lb. by $4\frac{5}{9}$.

38. Divide 95 tons 19 cwt. 3 qr. 11 lb. 9 oz. by $3\frac{1}{4}$.

39. If 80 tons 16 cwt. 3 qr. 11 lb. of metal be conveyed by the railway company for £10, what ought to be the charge for conveying 1091 tons 7 cwt. 1 qr. 22 lb. 8 oz.

40. The price of an ounce of metal being £1, 17s. 8½d. what will be the cost of 919 oz. 10 dwt.?

41. How many times is 70041 tons 13 cwt. 2 qr. 8 lb. contained in 1015604 tons 6 cwt. 3 qr. 4 lb.?

- 42. Find the least common multiple of 27, 35, 40, and 60.
- 43. Find the least common multiple of 85, 170, 69, and 13.
- 44. Find the least common multiple of 20, 65, 84, and 91.
- 45. Take $28\frac{3}{7}$ from $100\frac{3}{8}$ and divide the answer by $\frac{1}{8}$ of 3.
- 46. Multiply sixty thousand one hundred and ninety-three by ten thousand and eighty-eight, and find how many must be taken from the product to leave one hundred thousand.
- 47. Reduce 35016 to a vulgar fraction.
- 48. Simplify $\frac{27.65}{.0875}$
- 49. Reduce $\frac{6}{13}$ to a decimal.
- 50. Find the value of $8\frac{1}{3} \times 7\frac{3}{4} \times \frac{£16\frac{1}{3}}{£15\frac{1}{3}}$ as a decimal number.
- 51. Reduce to a decimal $\frac{82\frac{3}{5}}{93}$ | 52. Reduce $\frac{3\frac{3}{4}}{7\frac{3}{5}}$ to a decimal.
- 53. Express $\frac{104\frac{1}{2}}{28\frac{3}{2}}$ as a decimal number.
- 54. Find the cost of 17.5 acres at £603.8 per acre.
- 55. Express $\frac{4\frac{4}{5} \times 8\frac{1}{7} \times 3}{100 \times 1\frac{1}{5}}$ as a vulgar fraction.
- 56. Express $\frac{110.05 \times 6.3}{7.7 \times 6}$ as a decimal number.
- 57. Divide 830 crowns between three persons, and give the first 3 crowns more than the second and 7 crowns more than the third.
- 58. If $\frac{3}{4}$ of a sum of money be £100, 17s. 8d., what will $1\frac{1}{3}$ that sum of money be?
- 59. If $\frac{2}{3}$ of a sum of money be £80, 10s. 6d., what will $1\frac{1}{3}$ that sum of money be ?
- 60. What is the value of 5⁸/₄ times that sum of money of which ⁶/₁₈ is £1604, 16s. 9d.?
- 61. Reduce 2s. 6d. to the decimal of 3s. 9d., and multiply the result by the decimal which expresses the relation which 10s. 2d. bears to 15s. 3d. Divide the product by the decimal which is equal to

$$\frac{8s.}{5s. 4d.} \times \frac{10s. 6d.}{2s. 4d.}$$

Example XXVI.

Find the simple interest on £705, 6s. 8d. at $6\frac{2}{3}$ per cent. in 6 years.

1st Method.

- 1. Multiply £705, 6s. 8d. by 63.
- 2. Multiply the result by 6.
- 3. Divide the product by 100.

2d Method.

This is the usual method, but the student will see from the workings given below that it is more convenient in this case to multiply first by the number of years, because in this way we avoid some tedious operations with fractions of pence.

3d Method.

Express the whole operation as a compound fraction, and then find the value of this fraction.

	•	Workings.	
18	t Method.	2d	Method.
£705 16	8×6% 6	£705 16	8 6
£4235 0 235 5		£4235 0	6
235 5 £4705 11	63 13 6	£25,410 0 1411 13 1411 13	4
£282·33 6 20 6·66s. 12 8·00d.	8	£282 33 6 20 6 66s. 12 8 00d.	

Answer £282, 6s. 8d.

3d Method.

Answer =
$$\frac{\pounds705, 16s. 8d. \times 6\frac{3}{3} \times 6}{100}$$

= $\frac{\pounds705\frac{1}{3} \times 6\frac{3}{3} \times 6}{100}$ [See Example XIV.]
= $\frac{\pounds4235 \times 20 \times 6}{6 \times 3 \times 100}$ = $\pounds\frac{847}{3}$ = £282, 6s. 8d.

Example XXVII.

Find the simple interest on £270 in $6\frac{1}{4}$ years at $3\frac{1}{5}$ per cent.

In this example the improper fractions which correspond to the years and the rate per cent. are such that the denominator of each one of them is an exact measure of the numerator of the other, and their product must therefore be an integral number; thus

$$6\frac{1}{4} \times 3\frac{1}{4} = \frac{\frac{5}{25}}{\frac{1}{4}} \times \frac{\frac{1}{15}}{\frac{1}{5}} = 20$$

In such cases the working may be shortened, for the answer is found by multiplying the given principal by the integral number above referred to and then dividing by 100.

In the example before us the integral number happens to be an exact measure of 100, for $100 \div 20 = 5$; and therefore the answer may be found by dividing the principal by 5; thus

£270
$$\div$$
 5 = £54 Answer.

Exercise 34.

Simple Interest.

Note.—Since 5 is $\frac{1}{20}$ of 100, the simple interest for one year at 5 per cent. can be found by dividing the principal by 20.

Again, since

we find that for one year the

Simple interest at 10 per cent. = $\frac{1}{10}$ of the principal. Simple interest at 20 per cent. = $\frac{1}{5}$ of the principal. Simple interest at $16\frac{2}{8}$ per cent. = $\frac{1}{6}$ of the principal.

Simple interest at $6\frac{2}{3}$ per cent. = $\frac{1}{15}$ of the principal. Simple interest at $6\frac{1}{4}$ per cent. = $\frac{1}{15}$ of the principal. &c., &c., &c., &c., &c.

So that we can find the

Simple interest at 10 per cent. by dividing the principal by 10. Simple interest at 20 per cent. by dividing the principal by 5. Simple interest at 16% per cent. by dividing the principal by 6. &c., &c., &c., &c.

And, if the amount of interest be given, we can find the Principal by multiplying the given interest at 10 per cent. by 10. Principal by multiplying the given interest at 20 per cent. by 5. Principal by multiplying the given interest at $16\frac{2}{5}$ per cent. by 6. &c., &c., &c., &c.

- Find the simple interest for one year at 5 per cent. on £865, 10s.
- 2. If the simple interest for one year at 5 per cent, be £14, 2s. 3d., what is the principal?
- 3. What is the simple interest at 10 per cent. for one year on £5605, 12s, 6d. ?
- 4. If the simple interest at 10 per cent. for one year be £71, 2s. 9d., what is the principal?
- Find the simple interest at 20 per cent. for one year on £857, 15s.
- 6. The simple interest at 20 per cent. in one year is £1, 14s. 5d., what is the principal?
- 7. The simple interest at 20 per cent. in six months is £13, 18s. 2d., what is the principal?
- Find the simple interest at 16²/₈ per cent. for one year on £1750, 18s.
- 9. Find the amount of £2600 in one year at $16\frac{2}{3}$ per cent.
- Find the principal when the simple interest in one year at 16²/₃ per cent. is £41, 1s. 5d.
- Find the principal when the simple interest in three months at 4 per cent. is £5, 5s. 8d.
- 12. Find the amount to which a sum of money would be raised

in one year at $6\frac{2}{3}$ per cent. simple interest if the interest thereon in three months be £51, 1s.

13. Find simple interest in one year at $6\frac{1}{4}$ per cent. on £356, 10s.

14. What is the principal when the simple interest in one year at 6½ per cent. is £23, 18s. 1½d.?

15. To how much would that sum of money amount in six months the simple interest on which in that time at 6½ per cent. is £105, 8s. 2d.?

16. Find the simple interest on £860 in 9 years at 5 per cent.

17. Find the simple interest on £9290 in 8 years at 4 per cent.

18. Find the simple interest on £1745 in 6 years at 4 per cent.

Find the simple interest on £18,080 in 11 years at 3½ per cent.
 Find the simple interest on £10,071 in 2½ years at 1½ per cent.

21. Find the amount of £6145 in $12\frac{1}{2}$ years at 8 per cent.

22. Find the amount of £26,345 in $17\frac{1}{3}$ years at $3\frac{1}{8}$ per cent.

23. Find the amount of £6938 in 5 years at $7\frac{1}{7}$ per cent.

24. Find the amount of £1000, 11s. 2d. in $4\frac{2}{8}$ years at $7\frac{1}{7}$ per cent.

Find the amount of £1367, 17s. 6d. in 12½ years at 25
per cent.

26. What is that principal the simple interest on which is £1406, 2s. 6d. when the money is put out for 7 years at $2\frac{1}{3}$ per cent.?

27. At what rate per cent. must £5805 be invested to produce £6192 of simple interest in 16 years?

28. What is that sum of money which in $7\frac{1}{2}$ years, at $8\frac{1}{2}$ per cent. simple interest, amounts to £3125, 19s. 9d.?

EXERCISE 35.

Find the simple interest on-

1. £18,600 in 1 year 7 months at 4 per cent. per annum.

 £19,096, 10s. 4d. in 1 year 5 months at 6²/₃ per cent. per annum.

3. £7900 in $2\frac{3}{4}$ years at 5 per cent. per annum.

4. £1850, 5s. in 2 years at $6\frac{1}{3}$ per cent. per annum.

5. £705, 10s. in 8 years at 4 per cent. per annum.

6. £7708, 8s. in 5¾ years at 3¾ per cent. per annum.

- 7. £145, 10s. in 9 months at $3\frac{1}{3}$ per cent. per annum.
- 8. £451, 10s. in $3\frac{3}{4}$ years at $8\frac{1}{3}$ per cent. per annum.
- 9. £1604, 10s. in $5\frac{1}{2}$ years at $3\frac{3}{4}$ per cent. per annum.
- 10. £313, 15s. in 8 years at $2\frac{1}{3}$ per cent. per annum.
- 11. £1771, 10s. in 8 years at $4\frac{1}{3}$ per cent. per annum.
- 12. £830, 10s. in 6 years at $3\frac{1}{3}$ per cent. per annum.
- 13. £1258, 10s. in $8\frac{1}{3}$ years at $7\frac{1}{3}$ per cent. per annum.
- 14. £8086, 10s. in $8\frac{1}{3}$ years at $7\frac{3}{4}$ per cent. per annum.
- 15. $61\frac{3}{4}$ guineas in $11\frac{3}{4}$ years at $2\frac{1}{2}$ per cent. per annum.
- 16. £1693, 15s, from 15th April 1875 till 13th March 1876 at $5\frac{1}{8}$ per cent. per annum.
- 17. £77,097, 19s. 3d. for $8\frac{1}{3}$ years at $2\frac{1}{3}$ per cent. per annum.
- 18. £25,080, 10s. in $3\frac{1}{2}$ years at $5\frac{1}{4}$ per cent. per annum.
- 19. 22,000 guineas for $6\frac{1}{8}$ years at $8\frac{3}{4}$ per cent. per annum.
- 20. £38,040, 4s. in $5\frac{1}{2}$ years at $6\frac{1}{3}$ per cent. per annum.
- 21. £1705, 10s. in $4\frac{1}{2}$ years at $7\frac{1}{2}$ per cent. per annum.
- 22. £807, 15s. in $6\frac{3}{7}$ years at $3\frac{3}{7}$ per cent. per annum.
- 23. The value of 202 acres of land at £380, 12s. 6d. per acre, at $8\frac{2}{3}$ per cent.
- 24. £866 for 91 years at 4½ per cent. per annum.
- 25. 52,000 guineas in $4\frac{1}{3}$ years at $3\frac{3}{4}$ per cent. per annum.

Example XXVIII.

Stocks.

Find the annual income arising from £29,050 invested in $3\frac{1}{2}$ per cent. stock at $94\frac{1}{2}$.

Answer = £3
$$\frac{1}{2}$$
 × $\frac{£29,050}{£94\frac{1}{2}}$
= £ $\frac{7 \times 2 \times 29,050}{2 \times 189}$
= £1075, 18a, 6\frac{2}{3}d.

EXERCISE 36.

Simplify the following quantities:-

1.
$$\frac{\pounds26,382}{\pounds82\frac{3}{4}} \times \pounds3\frac{1}{2}$$
 4. $\frac{\pounds18,620}{\pounds90\frac{1}{8}} \times \pounds3$ 7. $\frac{\pounds28,001}{\pounds79\frac{1}{2}} \times \pounds4\frac{1}{2}$ 2. $\frac{\pounds2200}{\pounds109} \times \pounds3$ 5. $\frac{\pounds91,096}{\pounds105} \times \pounds4$ 8. $\pounds3\frac{1}{4} \times \frac{\pounds6086}{\pounds89\frac{1}{2}}$ 3. $\frac{\pounds3700}{\pounds82\frac{1}{2}} \times \pounds4\frac{1}{2}$ 6. $\pounds2\frac{3}{4} \times \frac{\pounds10,356}{\pounds82\frac{3}{4}}$ 9. $\pounds3\frac{3}{4} \times \frac{\pounds7325}{\pounds85\frac{1}{2}}$

Find the annual income in the following cases:—

- 10. £16,050 invested in the 3½ per cent. stock at 99.
- 11. £8030 invested in 63 per cent. stock at 101½.
- 12. £90,090 invested in 5 per cent. stock at 103.
- 13. £2706 invested in 3½ per cent. stock at 82½.
- 14. £6550 invested in 3 per cent. stock at 921.
- 15. £5775 invested in 3½ per cent. stock at 87§.
- 16. £6608, 10s. invested in 3 per cent. stock at 77%.
- 17. £1280, 18s. invested in Russian 6 per cent. stock at 1031.
- £9909, 10s. invested in 3 per cent. consols at 91½.
- 19. £2025, 15s, invested in 4 per cent. stock at 914.
- 20. Fifteen thousand guineas invested in 31 per cent. stock at 90‡.
- 21. £2063, 10s. invested in 31 per cent. stock at 831.
- 22. £7506 invested in $3\frac{1}{2}$ per cent. stock at $87\frac{3}{4}$.
- 23. £8605, 5s. 5d. invested in 3 per cent. stock at 881.
- 24. Ten thousand guineas invested in 4 per cent. stock at 88%.
- 25. If a person who has invested ten thousand pounds in 3 per cent. consols at 97 sell out at the same price, and invest the proceeds in 6 per cent. Russian stock at 1011, what difference will he make in his income?

EXERCISE 37.

- 1. Find simple interest on £1803, 10s. in 111 years at 31 per
- 2. Find simple interest on £1800, 19s. 74d. in 64 years at 48 per cent.

- Find simple interest on £1991, 10s. in 12½ years at 6 per cent.
- Find simple interest on £838, 10s. in 9½ years at 3½ per cent.
- Find the annual income on seven thousand pounds invested in the 4 per cent. stock at 98½.
- 6. What is the annual income on five thousand eight hundred and one guineas in 3½ per cents. at 90%?
- 7. A person sells 1200 acres of land at £65, 10s. per acre, and invests the proceeds in consols (3 per cent.) at 98½; what annual income will he derive from this investment?
- 8. Suppose a person invests £2600 in the 3 per cents. at 87½, and afterwards sells out at 89¾, what does he gain by the transaction?
- 9. Suppose a person invests £85,000 in consols (3 per cent.) at 85½, and afterwards sells out at 90, what does he gain by the transaction?
- 10. What quantity of stock at 971 can be bought for £43,875?
- 11. What quantity of stock at 88\frac{2}{3} can be bought for £510,083, 6s. 8d.?
- 12. What amount of stock at $95\frac{1}{2}$ can be purchased for £5967, 10s.?
- What amount of stock at 87³/₄ can be bought for £4343, 12s, 6d.?
- 14. What amount of stock at $103\frac{5}{5}$ can be bought for £55,447?
- 15. What amount of stock at $99\frac{3}{8}$ can be purchased for £20,057, 3s. 9d. ?
- 16. What is the real rate per cent. obtained on money invested in 3 per cent. stock at 75?
- 17. Which is the best investment, 3 per cent. stock at 90 to or bank interest at 4 per cent.?
- 18. What is the real rate per cent. obtained on money invested in 6 per cent. stock at 105?
- 19. What is the real rate per cent obtained by investing in 5 per cent stock at 87½?
- 20. What is the real rate per cent. obtained on a sum of money invested in 3½ per cent. stock at 93?
- 21. What will be the cash payment for £6650 stock at 851?

- 22. How much money shall I realise by selling out £36,675 stock at 933.
- 23. How much must I pay for £8525 stock at 971 ?
- 24. What sum of money will purchase £4556 stock in the 3 per cents. at 89?
- 25. How much stock at 88½ must be sold out to provide sufficient funds to purchase £12,500 stock at 92½ \$

EXERCISE 38.

- 1. What number bears the same ratio to 8 that 17 does to 34?
- 2. What number bears the same ratio to 21 that 15 does to 40?
- 3. What number bears the same ratio to 102 that 130 does to 39?
- 4. What number bears the same ratio to 88 that 6s. 3d. bears to 20s. ?
- 5. What sum of money stands in the same relation to half-aguinea that 4 lb. bears to a quarter of a hundredweight?
- 6. How many horses worth £23 each are equal in value to 115 acres of land at £91 each?
- 7. How many pairs of gloves at 2s. 11d. a pair are worth 3 sewing machines at £3, 10s. each?
- 8. If 6 men earn £20, how much will 13 men earn in double the time?
- If a man earn £80, 0s. 7½d. in 3 weeks, how much will he earn in 11 weeks?
- How many men will earn £96 in one-seventh the time occupied by 84 men in earning £29, 8s.?
- 11. Five ounces of gold are worth £19, 1s. $10\frac{1}{2}$ d.; what is, therefore, the value of seven ounces?
- 12. If 18 horses can draw a load of 55 tons 16 cwt., how heavy a load will be drawn by 19 horses at the same rate?
- 13. What weight of lead can be purchased for £85 if the cost of 19 cwt. be £23, 15s.?
- 14. How much must be given for 203 sheep at the rate of £181, 10s. for 27?
- 15. When 36 baskets of oranges cost £17, 8s. 6d., what is the cost of 19 baskets?

- 16. How many pieces of linen are worth £100 when the price of 80 pieces is £266, 13s. 4d.?
- 17. The wages of 7 men are £129, 15s. 4³/₄d.; what will be the wages of 65 men at the same rate?
- 18. Eleven houses are worth £2606, 3s. 6d.; what is, therefore, the worth of 17 houses at the same price each?
- 19. Five men earn £102 in 8 weeks; how much will ten men earn in 7 weeks?
- 20. How many yards of calico at 5³d. a yard are worth 23 yards of silk at 17s. 6d. per yard?
- 21. How many yards of cloth at 14s. 3d. per yard are worth 342 horses at £25 each?
- 22. How many tons of metal at £33, 10s. per ton are worth $15\frac{1}{3}$ acres of land at 105 guineas per acre?
- 23. What will be the cost of 27 tons 15 cwt. when 17 tons cost £114, 11s.?
- 24. If I can purchase 154 tons 2 cwt. 2 qr. of coals for £5, what weight can I purchase for £72, 10s.?
- 25. An article which cost £6, 3s. 8d. is sold for £21, 12s. 10d., at the same rate of gain what was the cost of an article which was sold for £26, 5s.?

Proportion.

Operations involving proportion may often be simplified by attention to the following methods:—

We thus find that when two fractions have the same denominator, the relation existing between them is the same as that which exists between their numerators.

$$1.7 = \frac{11}{15}$$
 and $1.5 = \frac{18}{15}$;

1.7 and 1.5 are thus fractions having the same denominator, and they consequently come under the above rule. Besides

17: 1.5 may be expressed thus,
$$\frac{17}{1.5}$$

But $\frac{1.7}{1.5} = \frac{1.7 \times 10}{1.5 \times 10}$ (vide § 59 of Advanced Arithmetic).
 $= \frac{17}{1.5}$

So that if two decimal quantities have each the same number of decimal places, the relation existing between them is the same as that which exists between the new quantities found by omitting the decimal points.

For example-

(a) 21·35	: 1.17	::	2135	: 117
(b) 14·18	: 03	::	1418	: 3
(c) 16·5 i.e., 16·50	: 13·81 : 13·81	::	1650	: 1381
(d) 3 i.e., 300	: 003	::	300	: 3
(e) 5 i.e., 500	: 02 : 02	::	500	: 2.

Example XXIX.

If A can do a piece of work in 4 days, B in 3 days, and C in 7 days, each day consisting of 10 hours; in how many hours can they do it when all work together?

(i.) In one day

A does 1 of the work
B does 1 of the work
C does 1 of the work

Therefore, when all work together, in one day they do $(\frac{1}{2} + \frac{1}{4} + \frac{1}{4}, i.e.)$ \$\frac{1}{2}\$ of the work.

(ii.) . · . § of the work : § of the work : : 10 hours : Answer i.e., 61 : 84 : : 10 hours : Answer

...
$$Answer = \frac{10 \text{ hours} \times 84}{61} = 1347 \text{ hours.}$$

N.B.—The operation (ii.) may be shortened thus :-

In one day \$\frac{2}{4}\$ of the work is done;
... to do all the work, \$\frac{2}{3}\$ of a day is required.
and ... Answer=\$\frac{2}{3}\$ of 10 hours=13\frac{7}{4} hours.

[Note well the line A.]

EXERCISE 39.

- Find the value of 360 times that sum of money which, being divided by 12, gives 17¹/₄d.
- 2. If a person's income for \(\frac{2}{3}\) of a year be £1060, what will be his income in 8\(\frac{1}{3}\) years, at the same rate?
- 3. What is $6\frac{1}{4}$ times that sum of money which, when multiplied by 3, is £25,504, 11s. $1\frac{1}{2}d$.
- 4. In ³/₈ of a year a man earns sufficient money to buy 14 ac. 3 r. 20 po. of land; how much land would a year's earnings enable him to buy?
- 5. The simple interest on $\frac{3}{5}$ of a sum of money is £1, 6s. 6d.; what is the interest on the whole sum at the same rate?
- 6. If the simple interest on £5000 be £803, 18s. 4d., what will be the interest on £11,000?
- 7. Four-fifths of a ton of coals are worth 17s. 8d.; what is the value of $2\frac{1}{2}$ tons of the same coals?
- 8. The value of my house being 5 of the value of that of my friend, what is the value of his house when mine is worth £9008, 12s, 6d.?
- 9. What is that sum of money the double of which is to £805, 15s. 6d. as 7:6?
- 10. What is $\frac{3}{6}$ of that quantity $\frac{3}{4}$ of which is 51 ac. 2 r. 10 po.?
- 11. The value of a horse is \$\frac{1}{3}\$ that of a cow, and the value of a cow is £13, 4s.; what is the value of 2 horses and 3 cows?
- 12. What will be the price of 17 ac. 3 r. 15 po. of land when 3 ac. 2 r. cost £21, 12s. 10d. ?
- What is 73 times that number which, being multiplied by 3, gives 863,013519
- 14. How many acres of land can be purchased for £9, 18s. 11½d. when 85½ acres are bought for £340, 4s. 4½d. ?
- 15. What is 3 times that number which, being divided by 1631, gives 850,018?
- 16. A can build a wall in 6 days, C in 11 days, B in 12 days; in how many days will they do it all working together?
- 17. If A can do a piece of work in one day of 6 hours, B in one day of 4 hours, and C in one day of 9 hours, in how many hours can they do it if they all work together?

18. A can do a piece of work in 32 days, B in 24 days, and C in 15 days; how long will it take the three, working together, to do \(\frac{2}{3}\) of the work?

19. One cubic inch of metal weighs 49 lb.; what is the weight, in lbs., of 23 cubic inches?

20. One cubic inch of water weighs 252.5 gr., and 100 cubic in. of air weigh 31 gr. Express by a decimal the number of times that water is heavier than air.

21. If a cubic inch of mercury weigh '49 lb., how many pounds of mercury will just fill a small cistern which is 7 in. long, 5 in. broad, and 8 in. deep?

22. What fractional part of a 10-acre field is 4 ac. 2 r. 20 po ?

23. At a certain shop the ready-money price of the goods is to the credit price as 9:10. If I purchase 85 yd. of silk at 10s. 9d. per yd., 75 yd. of cloth at 18s. 2d. per yd., and 23 yd. of velvet at 23s. 6d. per yd., credit prices, how much ready money will pay the bill?

24. A cistern is full of water, and contains a thousand gallons. Two taps are now turned, one of which removes 10 gallons per minute, and the other brings into the cistern 7½ gallons per minute. After how many minutes will

the cistern be empty?

25. In the above-named cistern how many gallons would be remaining after 201 minutes?

EXERCISE 40.

 Eight hundred bricks weigh two thousand pounds; how many bricks weigh 2½ tons?

2. A person has 3 beautiful and rare vases for sale, for which he asks a certain price, but cannot get it. He then breaks one of them, and asks for the remaining two 1½ times as much as he had before asked for the three; still he cannot sell them. He then breaks another, and asks for the remaining vase half as much again as he had just before asked for the two. Find the relation existing between the price this one bears at the first to that it bears at the last.

- 3. A person buys eggs at 5s. the gross, and sells them at 11 for 5d. If the "gross" consist of thirteen "dozens," and each "dozen" be thirteen, find the ratio which his gain bears to his outlay.
- Express, by a vulgar fraction, the ratio of ³/₆: ⁷/₉, and multiply 19 yd. 2 ft. 10 in. by the result.
- Express, by a vulgar fraction, the ratio which 15½ bears to ½, and multiply £68, 18s. 6d. by the result.
- Express, by a decimal, the ratio 2²/₅: 4²/₅, and multiply 27 tons 17 cwt. 2 qr. by the result.
- Express, by a decimal, the ratio 5½: 3½, and divide 18 tons 15 cwt. 3 gr. by the result.
- 8. A clock is worth 13 watches; a watch is worth 3½ guineas. What are 7 clocks worth?
- 9. The law-charges on the purchase of a house valued at £530 are £11, 12s. 6d. At the same rate, what will be the value of a house, the law-charges on the purchase of which are £29, 1s. 3d.?
- 10. As 22:7, so is the circumference of a circle to its diameter. What will therefore be the diameter of a circular pond which is 33 yds. round?
- 11. Also, if a dog can swim across a circular pond in 5 minutes, how long would it take him to swim round its margin at the same rate?
- 12. The weight of 53 sovereigns is 6558.75 grains; what is therefore the weight (in grains) of 27 sovereigns?
- A bankrupt pays 3s. 5d. in £1; how much does a creditor receive therefore on a debt of £85, 10s. ?
- 14. If a bankrupt pays 13s. 6d. in £1, how much will one of his creditors lose on a debt of £25, 6s. 8d.?
- 15. If I receive £7, 6s. 8d. as the settlement of a debt of £20, how much did the bankrupt pay in £1?
- 16. How much will a bankrupt pay in £1 if his debts are to his assets as 1 x : 1 x ?
- 17. A bankrupt's assets are to his debts as '54:1.6. If his debts be £3500, and I receive nine guineas as a settlement of a debt of £40, what sum of money was spent in lawyers' fees and other expenses incidental to settling the bankrupt's affairs?

18. A poor rate of 10½d. in the £1 is levied on property assessed at £285 per annum; what amount of money will the rate yield?

19. A post which is 15 ft. high casts a shadow which is 18 ft. 6 in. long; how many feet high is a neighbouring tower which at the same moment casts a shadow 160 ft. long?

- 20. After paying 11 men £61, 3s. 6½d. each, I find I still have £187, 1s. 0½d. left. If all my money, in the first place, consisted of ten-pound notes, how many of these notes had I?
- 21. If '3 of an acre of land be rented for £17, 16s. 3d., how many acres were rented for £409, 13s. 9d. at the same rate?
- 22. If 1·1 acre of land cost £331, 14s. $4\frac{1}{2}$ d., what will 9·7 acres cost?
- 23. The price of '7 of a yard of cloth is 12s. 3d.; what is, therefore, the price of 20½ yards?
- 24. 18.6 times a certain weight is 412,229 cwt. 26 lb. 14 oz.; what is three times that same weight?
- 25. A truck of coal contains 17 tons, 13 cwt.; the truck itself weighs 4 tons 19 lb.; how many of these loaded trucks will weigh 1949 tons 3 cwt. 30 lb.?
- 26. Which will benefit a man more, to have his wages raised 25 per cent., or to reduce the average prices of things 25 per cent.? Explain your answer by means of a simple ratio.

Example XXX.

If the simple interest on a sum of money invested at $2\frac{1}{3}$ per cent. per annum for a certain time be £81, 5s. 3d., what would the interest have come to in the same time if the rate per cent, per annum had been $3\frac{3}{4}$?

1st Method.

As $2\frac{1}{2}:3\frac{3}{2}::$ the simple interest at $2\frac{1}{2}$ per cent. : the simple interest at $3\frac{3}{2}$ per cent.

i.e. As $2\frac{1}{2}:3\frac{3}{4}::£81, 5s. 3d.:Answer.$

. • £81, 5s. 3d. $\times 3\frac{3}{4} = Answer \times 2\frac{1}{2}$.

... $\frac{£81, 5s. 3d. \times 3\frac{3}{4}}{2\frac{1}{4}} = Answer.$

i.e. £121, 17s. 101d. = Answer.

2d Method.

Since $2\frac{1}{2} = 1\frac{1}{2} \times 2$ and $3\frac{3}{4} = 1\frac{1}{4} \times 3$

it follows that

 $2\frac{1}{2}:3\frac{3}{4}=2:3$

and the Answer, therefore = £81, 5s. 3d. \times 3

=£121, 17s. 10id.

N.B.—The information given at the head of Exercise 34 (pp. 38, 39) may often be applied, as here, to shorten processes, e.g.—

Since $6\frac{2}{3} = \frac{1}{16}$ of 100 and $6\frac{1}{4} = \frac{1}{16}$ of 100

it follows that

simple interest at 6% per cent. : simple interest at 64 per cent. : : 15 : 16.

Example XXXI.

The simple interest on £250 in a given number of years at a given rate per cent. is £120. If the number of years be to the rate per cent. as 4:3, find the rate per cent.

- (1.) As £250 : simple interest on £250 :: £100 : simple interest on £100. i.e., £250 : £120 : : £100 : simple interest on £100
 - ... Simple interest on £100 = $\frac{£120 \times £100}{£020}$
- (2.) Now this £48=rate per cent. x the number of years But the rate per cent.: the number of years as 4:3

Therefore, we are required to find two factors of 48 which shall be to each other as 4:3.

4 4 multiplied by any number (3.) Now $\frac{1}{3} = \frac{1}{3}$ multiplied by the same number

. , in the question, we have to divide 48 into two factors, which shall be found by multiplying 4 and 3 by some unknown number. What is this unknown number?

Let it be represented by a;

Then 4 times $a \times 3$ times a = 48

i.e. $4 \times a \times 3 \times a = 48$

i.e. $12 \text{ times } \alpha^2 = 48$

 $a^2 = 48 \div 12 = 4$

 $\cdot \cdot , \alpha = 2$

... 4 times a=8=the number of years and 3 times a=6= the rate per cent.

EXERCISE 41.

1. If the simple interest on a sum of money invested at 3³/₄ per cent. be £12, 10s. 6d., what would the interest have been if the money had been invested at 5 per cent.?

 A sum of money invested at 5 per cent. produces an income of £50, 5s. 10d.; what will be the income on the same

sum of money invested at 33 per cent.?

3. What will be the simple interest at 2½ per cent. on that sum of money which, being invested at 3½ per cent., produces an income of £180, 14s. 6d.?

4. The difference between the simple interest on a sum of money invested at 4 per cent. and the same sum invested at 3³/₄ per cent. is £60, 5s. 5d.; what is that

sum of money?

5. The difference between the simple interest on a sum of money invested at 2 per cent. for a year and on the same sum invested at 2 per cent. for 1 year and 3 months is £15, 10s.; what is that sum of money?

6. A sum of money invested for 6 months at 6¼ per cent. produces £7, 7s. more interest than when invested at 5 per cent.; what is the amount of annual interest at each rate?

7. In Question 6 what was the sum of money invested?

8. The difference of annual income between a sum of money invested at 6²/₃ per cent. and the same sum invested at 5 per cent. is £83, 16s. 3d.; what is the sum invested?

9. The difference of quarterly income between a sum of money invested at $6\frac{1}{4}$ per cent. per annum and the same sum invested at $6\frac{2}{3}$ per cent. per annum is one guinea; what is the sum invested?

10. What is that sum of money which when invested at 4 per cent. for 5 months produces £131, 8s. 9d. less interest than when invested at 2½ per cent. for 9 months?

11. What is that sum of money which, being invested at 4½ per cent. per annum for 6 months, produces £70, 17s. 6d. less simple interest than when invested for 9 months at 3¾ per cent. per annum?

12. A sum of money invested for a certain time at $2\frac{1}{2}$ per cent.

produces £50, 15s. simple interest; at what rate per cent. must it be invested to produce £76, 2s. 6d. simple interest in the same time?

13. What two rates per cent. of simple interest produce annual incomes which are to each other in the proportion of 65 to 52, if the annual income arising from £102, 16s. 3d. invested at the lower rate be £4, 2s. 3d.? Could the answer be found without using the information printed in italics?

14. A and B invest equal sums of money at different rates for 6 months. At the end of that time it is found that A's interest, which is £30, 18s., is to B's as \(\frac{1}{16} \) is to \(\frac{1}{16} \). Now the sum of money invested by each is £1353, 10s.; what are therefore their respective rates of interest? Could the answer be found without using the information printed in italics?

15. What is that sum of money which, being invested for 16½ years at 3½ per cent. per annum, produces £2387, 7s. 6d. simple interest?

16. What is that sum of money which, being invested for 30 years at 6\(\frac{2}{3}\) per cent. per annum, produces £3684 simple interest?

17. What sum of money must be put out for 10 years at 2\frac{3}{4}
per cent. per annum simple interest, in order that the
investor may be able to withdraw £2486, 17s. 9d. at
the end of that time?

18. For how long must £27,075 be put out to simple interest at 5\frac{1}{3} per cent. per annum in order to gain £1925, 6s. 8d.?

19. For how long must £82,000 be invested at 6\(\frac{2}{3} \) per cent. simple interest, that at the end of that time it may amount to £174,933, 6s. 8d. ?

20. The simple interest on £8800 put out for a given time at a given rate is £660; if the number of years be the rate per cent. in the ratio of 6:5, what is the number of years and what the rate per cent.?

21. The simple interest on £9200 is £1022, 4s. 5½d.; if the number of years at which it is invested be to the rate per cent. at which it is invested at 2:1¼, find the number of years and the rate per cent.

22. At what rate per cent., and for how many years, must £2505 be invested at simple interest to gain £603, 5s. 9d., when the number of years is to the rate per cent. as ½: ½?

23. £675 is the simple interest on £10,800; for how many years, and at what rate per cent., was the money invested, seeing that the number of years was 1½ of the rate per cent.?

24. A sum of money is to the simple interest thereon in $1\frac{1}{2}$

years as $3\frac{1}{3}:\frac{1}{4}$; what is the rate per cent.?

25. A sum of money is to the simple interest thereon in 2½ years as 20:3; what is the rate per cent.?

Example XXXII.

For how much must an article be sold to gain 20 per cent. if the selling price to lose 20 per cent. be 12s.?

1st Method.

(i.) Find the cost price of the article: thus—

If a person lose 20 per cent. on the sale of an article, he will receive only [£100 - £20, i.e.] £80 for every £100 laid out: therefore

The selling price to lose 20 per cent. : cost price :: 80 : 100

i.e. 12s. : cost price :: 80 : 100.: cost price $\times 80 = 12s. \times 100$

... cost price =
$$\frac{12s. \times 100}{80}$$
 = 15s.

(ii.) Find the selling price to gain 20 per cent.: thus— If a person gain 20 per cent. on the sale of an article, he will receive [£100+£20, i.e.] £120 for every £100 laid out: therefore

The selling price to gain 20 per cent. : cost price :: £120 : 100

i.e. The answer: 15s.:: £120: 100

.. Answer $\times 100 = 15s. \times 120$

... Answer = $\frac{15s. \times 120}{100}$ = 18s.

2d Method.

(i.) A loss of 20 per cent. = a loss of 20 out of every 100 laid out.= a loss of 1 in every 5 laid out.

... In such a case the loss $= \frac{1}{4}$ of the outlay.

But if a person lose ‡ of his outlay he will have ‡ remaining;

... by the question, 12s. is 4 of the cost price;

and . . . the cost price = 4 of 12s. = 15s.

(ii.) And, similarly-

A gain of 20 per cent. = a gain of 1 on every 5 laid out.

. . . In such a case the gain = ‡ of the outlay.

= ‡ of 15s,

= 3s.

. . The selling price to gain 20 per cent. = 15s. + 3s. = 18s. Answer.

3d Method.

A person who loses 20 per cent. receives £80 for every £100 spent, and a person who gains 20 per cent. receives £120 for every £100 spent.

Therefore

And, by the question, this becomes:-

12s.: Answer:: 80:120 .:. Answer \times 80 = 12s. \times 120 .:. Answer = $\frac{12s. \times 120}{80}$ = 18s.

[The third method is the most expeditious, and may be adapted to more complicated cases, as in the following example.]

Example XXXIII.

For how much must an article be sold to gain 30 per cent., if the selling price to lose 12 per cent. be 11s.?

If a person lose 12 per cent. he receives 88 for every 100 expended; if he gain 30 per cent. he receives 130 for every 100 expended.

Therefore

Or, by the question-

88:130::11s.:Answer Therefore, Answer × 88=11s. × 130

... Answer =
$$\frac{11s. \times 130}{88}$$
 = 16s. 3d.

Example XXXIV.

What is the real rate of interest obtained by investing in the $3\frac{1}{2}$ per cents. at 91?

The interest on £91 = £3
$$\frac{1}{4}$$
... The interest on £100 = £3 $\frac{1}{4}$ × $\frac{£100}{£91}$ = £3 $\frac{1}{4}$ 1

... The real rate of interest = 311 per cent. Answer.

Example XXXV.

Express by a decimal fraction the relation which the annual income on £8000 invested in 4 per cent. stock at 104 bears to £9600 invested in the 3\frac{1}{4} per cents. at 80.

The income from £8000 in the 4 per cents. at $104 = £4 \times \frac{£8000}{£104}$

And, the income from £9600 in the 3½ per cents. at $80 = £3½ \times \frac{£9600}{£80}$

... The Answer =
$$\frac{£4 \times \frac{£8000}{£104}}{£3\frac{1}{2} \times \frac{£9600}{£80}} = \frac{£\frac{4 \times 8000}{104}}{£\frac{7 \times 9600}{2 \times 80}} = \frac{\frac{4 \times 8000}{104}}{\frac{7 \times 9600}{2 \times 80}} = \frac{\frac{4 \times 8000}{104}}{\frac{104}{2 \times 80}} = \frac{\frac{1}{2} \times \frac{8000}{2} \times \frac{1}{2} \times \frac{1}{2}}{\frac{1}{2}} = \frac{200}{273}$$
= 782600.

EXERCISE 42.

- What is the annual income on £2655 invested in 3½ per cent. stock at 89¼?
- What is the quarterly income on £16,058, 8s. invested in 5 per cents. at 102; ?
- What is the real rate per cent. obtained by investing in 3³/₄ per cent. stock at 85⁵/₈?
- 4. What is the real rate per cent. obtained by investing in 5 per cent. stock at 101½?

- 5. I invest in certain stock at 96\frac{1}{2} and find the real rate of interest is $4\frac{128}{198}$ per cent. What is the nominal rate per cent. of this stock?
- 6. By investing in certain stock at 86% I find I am really receiving $3\frac{250}{347}$ per cent. on my money. What is the nominal rate per cent. of this stock?
- 7. What quantity of stock can be bought at $94\frac{1}{5}$ for £8148, 6s. 1
- 8. What quantity of stock at £77 $\frac{3}{4}$ can be bought for £4645.5625 1
- 9. What quantity of stock at 123 can be bought for £7953·375 i
- 10. What quantity of stock will be obtained by investing £88,565 in 3 per cent stock at 91, and what will be the annual income thereon?
- 11. How much stock must be sold out at 85 to realise £2125?
- 12. How much stock must be sold out at $89\frac{5}{5}$ to realise £3189, 1s. 8d. ?
- 13. When the funds are at $93\frac{7}{12}$ how much stock must be sold
- out to realise £5931 $\frac{87}{1128}$?

 14. When the funds are at $94\frac{1}{6}$ how much stock must be sold out to realise £7589.48125?
- 15. Which is the better investment, the 3 per cents. at 85 or the $4\frac{1}{5}$ per cents. at $127\frac{1}{5}$?
- 16. Which is the better investment, $3\frac{1}{7}$ per cent. stock at $81\frac{19}{24}$ or simple interest at 4 per cent.?
- 17. Express, by a fraction in its lowest terms, the proportion which the real interest in the 3 per cents, at 81 bears to that in the 4 per cents. at 101.
- 18. Express, by a vulgar fraction, the proportion which the real rate of interest in the 5 per cents. at 104 bears to that in the 6 per cents. at 125.
- 19. Express, by a vulgar fraction, the relation which the real interest in the $3\frac{1}{3}$ per cents. at 78 bears to that in the 41 per cents. at 991.
- 20. Express, by a decimal, the proportion which simple interest at $2\frac{1}{2}$ per cent. bears to the real rate of interest in $3\frac{1}{4}$ per cent. stock at 108.
- 21. Express, by a decimal, the ratio in which the true in-

terest stands to the nominal interest in the 4 per cents. at 88.

- 22. At what price is 3 per cent. stock when a person can purchase £650 stock for £576, 17s, 6d.?
- 23. At what price is stock selling when £9000 stock is purchased for £6817, 10s.?
- 24. At what price are the funds when a person gives £6962, 10s. for £7500 stock?
- 25. At what price are the funds when a person gives £19,145, 5s. for £19,050 stock?

Example XXXVI

A person's income-tax amounts to £3, 3s. at a time when it is fixed at 6d. in the £1, a rebatement of £120 from the income being made when it is under £400. What is the person's income?

£3, 3s. = 63s. = 126 sixpences

- ... the income paid on=£126
- ... the total income = £126 + £120 = £246 Answer.

Example XXXVII.

A person sells an estate for £12,000 and invests the money in 3 per cent. consols at 93, paying 2s. 6d. per cent. on the stock purchased. If the conditions of income-tax be the same as in Example XXXVI., what clear income does he receive from the investment?

- (1) Each £100 stock costs £93 + commission = £93, 2s. 6d. = £93\frac{1}{4}.

 Therefore the gross income = $\frac{£12,000}{£93\frac{1}{4}} \times £3$ = £386, 11s. 6d.
- (2.) Income-tax will be paid on £386 £120 = £266; and will, therefore, amount to 266 sixpences = 133s. = £6, 13s.
- (3.) Therefore the clear income will be £386, 11s. 6d. £6, 13s. = £379, 18s. 6d. Answer.

EXERCISE 43.

- What income does a person derive from £8990 stock in the 3½ per cents.?
- 2. What sum will he realise by selling out at 95 ?
- How much Dutch 2½ per cent. stock at 88 can be purchased with the proceeds?
- 4. And what will be the income on the new investment?
- 5. If a person transfer £58,550 stock from the 3 per cents. at 91 to the 4 per cents. at 112, what quantity of the latter stock will be obtain, and what alteration will be made in his annual income?
- 6. A person who holds £20,565 South Australian 4 per cent. stock sells it out at 95¾ and invests the proceeds in New Zealand 4½ per cents. at 93. What quantity of the New Zealand stock does he buy, and what alteration will he make in his income?
- 7. And, in Question 6, what ratio does the real rate of interest in the South Australian stock bear to that in the New Zealand stock?
- 8. Great Western 5 per cent. debenture stock is at 131 and the North British 4 per cents. are at 102. If a person sell £1800 of the former stock and £2500 of the latter and invest the proceeds in consolidated 5 per cents. at 1282, what difference will he make in his income?
- 9. What difference will a Frenchman make in his income (expressed in francs) by transferring 15,000 francs which he had invested in 3 per cent. Rentes at 82.50 to the 5 per cents. at 115.80?
- 10. When Russian 6 per cents. are at 96³/₄ what shall I be required to pay for £5575 stock, including the usual commission for brokerage, viz., ¹/₈ per cent.?
- 11. A gentleman who holds £7600 of 4 per cent. funded (United States) stock sells out at 103½ and invests in French 5 per cents. at 113½; what difference will be made in his income for the first year when ½ per cent.*
- In all Government stock, both British and Foreign, this rate is charged upon the stock; in other securities it is charged upon the sum of money realised or the sum invested, as the case may be.

on the selling out and the same percentage on the re-

investment has been paid for brokerage?

12. How much will it cost me to purchase £6060 Indian 4 per cents. at 103\frac{3}{6}, including brokerage commission at \frac{1}{8} per cent.? and what annual income shall I derive from the investment?

13. How much will it cost me to purchase £9075 Chinese 6 per cents at 106½, including ½ per cent. for brokerage, and what annual income shall I derive from the investment?

14. How much money shall I obtain by selling out £27,050

Peruvian 6 per cents, at 141? What actual rate of

interest would investments in such stock pay?

15. A person invests £25,000 in United States 4 per cents. at 105%, and at the end of a year sells out and re-invests in 5 per cent. railway stock at 117½. At the end of six months this stock rises to 121; he therefore sells out. By how much has he increased his capital after deducting ½ per cent. brokerage in each transaction?

16. A person who has invested £86,000 in United States 5 per cents, at 87³/₈ sells out at the end of six months and reinvests in Chinese 6 per cents, at 107¹/₂. At the end of a year he finds this stock has fallen to 105³/₂, he therefore sells out and invests the proceeds in Japan 9 per cent, stock at 112; what is his income now, and by how much per cent, per annum has he increased it by his changes? [Brokerage ½ per cent, paid on each transaction.]

17. The United States 5 per cent, funded stock is now at 103. If that Government borrow £6,000,000, how much of the above-named stock will the lender receive for his

money?

18. When the United States $4\frac{1}{2}$ per cent. stock is at $105\frac{3}{4}$, how much of that stock will a lender of that sum receive who advances half a million of money to the Government?

19. When Consols are at $97\frac{1}{4}$, how much of this stock must be

created to cover a loan of £7,500,000?

20. French 5 per cents, are at 105 and the French Government wishes to raise a loan of £10,000,000. The money is advanced by a firm of bankers who receive £8,000,000 of the above-named stock and the rest in $5\frac{1}{2}$ per cents. How much of the latter stock will they receive?

21. When British 3 per cent stock is at 91 the Government borrow £3,000,000. If the lender receive £2,000,000 in the above-named stock, how much of the 3½ per cent stock must be receive in addition?

22. When Russian $6\frac{1}{2}$ per cents are at $83\frac{1}{4}$ the Government wish to borrow £20,000,000, the lender to receive £20,000,000 in the 6 per cents and a certain quantity of $6\frac{1}{2}$ per cent. stock. How much of the latter ought he to accept?

23. When Dutch $2\frac{1}{3}$ per cents are at $87\frac{3}{5}$ the Government borrow £2,000,000, giving the lender £1,000,000 of the above-named stock and the remainder in 3 per cent. stock. How much of the latter stock did he receive if he find he is making $\frac{1}{3}$ per cent. more in this way (on the whole investment) than he would have done had he invested the whole sum in the $2\frac{1}{3}$ per cents at the price above quoted?

24. A gentleman who has £20,000 invested at $4\frac{1}{2}$ per cent. hears that the French Government desires to borrow money, and therefore resolves to transfer his money to this new investment. He finds there is allotted to him £20,000 3 per cent. Rentes, then selling at 83.25, and a certain quantity of stock bearing interest at $3\frac{1}{2}$ per cent. How much of the latter stock will there be allowed him if his total income be $\frac{1}{6}$ per cent. greater than it would have been had he been allowed the exact equivalent to his £20,000 in the 3 per cent. Rentes, and by how much has he increased or decreased his annual income by this new investment?

25. By investing a sum of money at 5½ per cent. I secure an annual income which is £52 less than I should secure by investing one-half the sum of money as above, half the remainder in 3 per cent. Consols at 95, half the remainder in 3 per cent. Rentes at 83⅓, and the rest in 6 per cent. stock at 47½. What was the sum invested?

26. Under the conditions of income-tax assessment described in

Example XXXVI, a gentleman finds his gross income reduced to £399, 15s. when he is charged on the whole of it, and he therefore claims the rebatement of £120. If this claim be allowed, how much income-tax will he have to pay?

- 27. But, on the other hand, the collector argues that when the income-tax has been assessed on the reduced income the gentleman is left in possession of an income which is over £400, and therefore the rebatement should not be made. The commissioners decide to split the difference between the two calculations of income-tax, and if the gentleman's income be then over £400 he is to be allowed no rebatement. Under this arrangement what sum will he pay more than he would have done in Question 26?
- 28. If the claim set up by the gentleman in Question 26 had been altogether rejected, and he had then decided to insure his life for £500 at a charge of £2, 5s. per £100, how much would this insurance actually cost him per annum on the understanding that his annual payment to the insurance office is calculated as a rebatement of his income?

EXERCISE 44.

Profit and Loss.

- If an article be purchased for £8, for how much must it be sold to realise a gain of 20 per cent.?
- 2. For how much must an article which cost £95 be sold so that the seller may gain 5 per cent.?
- 3. Find the gain at 20 per cent. on an outlay of £7010.
- 4. What will be the gain at 25 per cent. on an outlay of £8608, 10s. ?
- 5. Find the gain at 30 per cent. on an outlay of £8605.
- 6. What is the cost price of an article the gain at 10 per cent. on the sale of which is £7, 7s. 1½d.?
- Find the gain at 12; per cent. on an outlay of £700, 16s. 8d.

- 8. What is the cost. price of an article whose selling price is £830 and the gain on which is £86, 7s.?
- At what price must an article which cost £8, 10s. be sold so that the seller may gain 40 per cent.?
- 10. What was the cost price of an article which being sold for £8000 realises to the seller a profit of 60 per cent.?
- Find the price at which an article which cost £1, 16s. must be sold to realise a gain of 25 per cent.
- 12. A person buys a house for £2605 and sells it again at a loss of 30 per cent. What is the selling price?
- 13. What was the cost price of an article which being sold for £13,027, 6s. realised a gain of 30 per cent.?
- Find the cost price of an article which when sold at a loss of 15 per cent. realises £1305.
- 15. Find the gain per cent. at which an article was sold when the cost price was £86 and the selling price was £107, 10s.
- 16. What was the selling price of an article on which a gain of £18, 17s. 9d. was made at the rate of 3½ per cent.?
- 17. Find the gain at $33\frac{1}{3}$ per cent. on £17,060.
- 18. Find the cost price of an article when the selling price to gain 20 per cent. is £7560.
- 19. What is the cost price of a piece of land which being sold for £18,080 realises a gain of 20 per cent.?
- 20. What is the selling price of a ship which costs £9900 and is sold at a gain of 35 per cent.?
- 21. Find the price at which a ship which cost 2000 guineas must be sold to realise a gain of 25 per cent.
- 22. Find the cost price and the selling price of an article which being sold at a profit of 8½ per cent. realises a gain of £19, 0s. 6d.
- 23. What was the cost price of an article which being sold at a gain of 6½ per cent. realises a profit of £15, 13s. 4d.?
- 24. A person buys a property and sells it again at a loss of 20 per cent. If the selling price be £8080, what was the cost price?
- 25. An article is sold at a loss of 22 per cent.; what was the cost price if the loss was £113, 7s. 10d.?

EXERCISE 45.

- If I buy 45 maps at 17s. 6d. each and afterwards sell them again to gain 50 per cent., what do I get for them?
- A man buys 83 yds. of silk at 16s. 8d. per yd. and sells it again at a gain of 25 per cent., what does he receive for it?
- 3. A bookseller buys 640 books at 3s. 6d. each, and sells them at a gain of 20 per cent., what does he get for the lot?
- 4. If a tobacconist should buy 60 oz. of tobacco at 2½d. an oz. and sell it again to lose 20 per cent., what would he get for it?
- 5. A miller buys 28 sacks of flour at 15s. a sack and sells it again at a profit of 20 per cent, how much does he get for it?
- Find the price for which a man sells 85 gallons of rum which cost him 16s. per gallon if he gains 25 per cent.
- 7. A gentleman buys a horse for 50 guineas and sells it again for £62, 10s., how much does he gain per cent.?
- Find the cost price of an article which is sold again at a gain of 10 per cent. and realises £85, 16s.
- 9. What is the cost price of an article which being sold at a loss of 32 per cent. realises £134, 11s. 2d. ?
- 10. Suppose a man sells land for £320 and finds he has lost 20 per cent, what did he give for it?
- 11. A man sells land for £250 and finds he has gained 11¹/₉ per cent., what was the cost price of the land?
- 12. A gentleman sells a cottage for £180 and finds he has gained 12½ per cent. on his purchase-money, how much does he gain?
- 13. For how much must a house which cost £950 be sold to gain 17 per cent. ?
- 14. What is the selling price to lose 10 per cent. when the cost price is £38, 8s. 4d.?
- 15. What is the cost price when the selling price to gain 62 per cent. is £276, 18s.?
- 16. What is the gain at 12½ per cent on an outlay of £7, 17s. 9d.?

17. If a piece of land cost £781, 17s., for how much must it be sold again to realise a profit of 111 per cent.?

18. What was the cost of that article which being sold again for £80, 6s. 8d. realised a gain of 22 per cent. to the seller?

19. An agent buys a house for £800 and sells it again at a loss of 13½ per cent.; what does he get for it?

20. For how much must land which cost £808, 8s. 6d. be sold to realise a gain of 61 per cent.? 21. What is the amount gained on the sale of an estate which

cost £8808, 10s. and was sold at a profit of 12½ per cent. ?

22. What did a person give for an acre of land which being sold again at a loss of 20 per cent. realised £92, 8s. ?

23. If a dealer buy 640 sheep at £8, 5s. each, for how much must he sell the whole flock in order to realise a gain of 10 per cent.?

24. A tradesman buys a quantity of tea for £1650, 16s. 8d. and sells it again at a loss of 15 per cent. What does

he get for it?

25. A merchant who has bought a cargo of goods for £2015, 15s., sells them again at a loss of 35 per cent.; what does he get for them?

EXERCISE 46.

True Discount.

1. Find the true discount on £18,068, 6s. due in a year at 5 per cent. per annum.*

2. What is the true discount on £52,000 due in 73 days at 5 per cent. per annum?

3. Find the true discount on £60,600 due in 6 months at 4 per cent. per annum.

4. What is the true discount on £60,060 due in 9 months at 63 per cent. per annum ?

5. What is the true discount on £30,300 due in 5 months at 6 per cent. per annum?

* This question fully expressed would run thus:—Find the true discount on £18,068, 6s. due in a year when the ordinary rate of bankers' interest is 5 per cent. per annum.

- Find the true discount on £8010 due in 3 months at 5 per cent. per annum.
- 7. What is the present worth of £2500 due in 3 months at 5 per cent. per annum?
- What is the present worth of £26,260 due in 2½ months, the current rate of interest being 6 per cent.
- Find the present worth of £8305 due in 2 months at 4 per cent. per annum.
- 10. What will a banker give me for a bill for £3035, 10s. 6d. payable 2 months hence, the current rate of interest being 5½ per cent. per annum?
- 11. What is the real value of a bill for £1900, 10s. payable 3 months hence, interest being at 6 per cent. per annum?
- 12. Find the present worth of £7707, 7s. due 8 months hence, interest being 8 per cent. per annum.
- 13. What is the present worth of £1648, 8s. due in 14 weeks, interest being at 4½ per cent. per annum?
- 14. Find the true discount on £1746, 6s. 8d. due in \(\frac{1}{3} \) year, interest being at 5\(\frac{1}{3} \) per cent. per annum?
- 15. What is the true discount on £8606, 16s. 3d. due in 3 months at $5\frac{\pi}{5}$ per cent. per annum?
- 16. What is the present worth of 2000 guineas due in 146 days at 3³/₂ per cent. per annum?
- Find the true discount on £80,078 due in 73 days at 4 per cent. per annum.
- 18. Find the true discount on £1880, 15s. due in 3 months, interest being at the rate of 5 per cent. per annum.
- 19. What is the difference between the present worth and the nominal value of £8118, 18s. 7d. due in 2½ months, the current rate of interest being 6 per cent.?
- 20. What is the difference between the present worth and the nominal value of £8600 due in 9 months, the current rate of interest being 5 per cent.?
- 21. What is the difference between the present worth and the nominal value of £18,180 due in 1 year, the current rate of interest being 12½ per cent.?
- 22. Find the true discount on £10,500 due in 2½ months when interest is 8 per cent. per annum.
- 23. What is the true discount at 911 per cent. on £6060?

- 24. What is the true discount in ½ year at 63 per cent. per annum on 410 guineas?
- 25. What is the present worth of a bill for £29,019 payable in 4 months, interest being at 7 per cent. per annum?

Example XXXVIII.

Three sums of money amount in all to £213, 5s. 8d.; the first is £1, 11s. 8d. more than the second, and the second is £30, 8s. 9d. more than the third. What is the value of each?

The third sum = the third sum the second sum = £30, 8s. 9d. + the third sum

... the first sum =£1, 11s. 8d. +£30, 8s. 9d. + the third sum

- .. the whole=£1, 11s. 8d.+[£30, 8s. 9d. \times 2]+[the third sum \times 3]. i.e., £213, 5s. 8d. =£1, 11s. 8d. +£60, 17s. 6d. +3 times the third sum
 - =£62, 9s. 2d. +3 times the third sum
 ... £213, 5s. 8d. -£62, 9s. 2d. =3 times the third sum
 - i.e., £150, 16s. 6d. = 3 times the third sum.
 ... £50, 5s. 6d. = the third sum

and (£50, 5s. 6d. +£30, 8s. 9d., i.e.)£80, 14s. 3d. = the second sum and (£80, 14s. 3d. +£1, 11s. 8d., i.e.)£82, 5s. 11d. = the first sum

EXERCISE 47.

- An article is sold for £14, 5s., and the seller finds he has lost 5 per cent. on his outlay; for what should he have sold it to realise a gain of 5 per cent. on his outlay?
- 2. If the selling price to gain 60 per cent. is 17s. 4d., what will be the selling price to lose 10 per cent.?
- A person gains 25 per cent. on his outlay by selling a boiler for £75; for how much must he sell it to gain 40 per cent.?
- 4. An engine is sold for £86, 7s. and the seller finds he has gained 10 per cent. on his outlay; at what price should he have sold it if he wished to make 30 per cent. on his outlay?
- 5. A coachbuilder finds that a gain of 13 per cent. on the cost (to him) of a carriage amounts to £19, 6s.; what would be the amount of gain on the same article calculated at 39 per cent.?
- The same builder sells a phaeton for £35 and finds he has made a gain of 40 per cent, on his outlay. If he had

sold it for such a price that his receipts were to his outlay as 6:5, what would he have got for the article?

7. It is found that the carriage of a stove from Glasgow to Manchester is 18 per cent. of the maker's price. percentage is this of the cost of the article to the person in Manchester?

8. The selling price of an article was £199, 19s. 44d. greater than its cost price, and the seller's gain in the transaction was $7\frac{1}{7}$ per cent.; find the cost price and the selling price.

9. The selling price being £50, and the cost price being £42.

10s.; what will be the gain per cent.?

10. If the gain on a ship which is sold at a profit of 20 per cent. be £2120, 2s. 2d., what will the buyer lose if he insure it for 83.3 of what he gave for it, and the ship be lost at sea? The cost of insurance not to be considered.

11. Divide £1910 among A, B, C, so that A's share may be 160 per cent. of B's, and C may receive 50 per cent. of

that given to A.

12. What was the marked price of cloth per yard when a purchaser paid £16, 3s. for 34 yards of it after receiving a discount of 5 per cent. on the bill!

13. What was the original purchase-money of a piece of land which being sold again at a loss of 63 per cent. realised £1577, 5s. 1

14. When the selling price to gain 72 per cent. is £1500, what

will be the selling price to lose 77 per cent.?

15. If a property when sold for 1000 guineas realises a profit of 18 per cent., for what should it be sold to realise a profit of 25 per cent.

16. For how much must an estate be sold to lose 15 per cent.

when £20,000 is the price to lose $17\frac{1}{2}$ per cent. !

17. Sea-water being 21 per cent. heavier than fresh water, and the weight of a cubic foot of the latter being 62.33 lbs. what is the weight (in lbs.) of a cistern of salt water, the length of the cistern being 20 ft., the height 13 ft., and the width 7 ft.?

18. And what will be the weight of salt water in another cistern which is twice as long and twice as broad but only one-half as deep as the one in question 17!

19. Divide £1000 between A, B, C, so that A may receive 30 per cent. and B 70 per cent. of the sum given to C.

- 20. A horse is sold for £35 and the seller finds he has gained $16\frac{2}{3}$ per cent. on his outlay. If he had sold the horse for £32, to what rate per cent. would his gain have amounted?
- 21. For how much must an estate be sold to gain 13½ per cent. when the price to lose 26½ per cent. is £17,500?
- 22. The cost of paper per ream having been reduced from 20s. 5d. to 20s. 2d. and other expenses of working a newspaper having been reduced 20 per cent. per ream of paper used, find the total percentage of reduction made in producing the newspaper.

23. If I sell oranges at five for 2d. I gain 5 per cent. How much shall I gain or lose per cent. by selling them at 32s. per

thousand?

24. An army goes into battle and loses 5000 men. Its numbers are now 80 per cent. of what they were before. By what percentage of its own number must the remaining force be now increased to raise the army to its original strength?

25. The sum of two decimal numbers is 160.8; the smaller number is 6 of the greater; what is the greater number, and what percentage does it form of their sum?

Example XXXIX.

If the charge for insuring a vessel be 10 per cent. of her value, for how much must a ship worth £1350 be insured so that if she is lost the owner may recover the value of the ship and the cost of her insurance?

If a person insure for £100 it will cost him £10 to do so.

.. If a person wish to insure a nett return of £90 he will be able to do so by paying the charge on £100: i.e., he must insure every £90 in the value of his ship, as £100.

Therefore, by the question, we get-

100:90::Answer:£1350

 $... Answer \times 90 = £1350 \times 100$

•. Answer = $\frac{£1350 \times 100}{90}$ = £1500.

EXERCISE 48.

- What must a man charge for an article which cost him £18, 10s. 8d., in order to gain 17½ per cent. thereon?
- 2. And what percentage will this profit form of the selling price?
- 3. The weight of a pound of gold (Troy) is what percentage of that of a pound of sugar (Avoir.)?
- 4. A ship is worth £12,500. If the rate of insurance be 3½ per cent., for what sum must the ship be insured so that, in case of loss, the owner may recover her value and the cost of insurance?
- 5. If insurance be charged at 2½ per cent., for what sum must a ship valued at £37,500 be insured so that, in case of loss, the owner may recover the value of the ship together with the sum paid for insurance?
- 6. Find the true discount on £80,888, 8s. at 4 per cent.
- Find the present worth of £2233, 11s. due in ½ year at 4½ per cent.
- 8. If the cost of insurance be 3\frac{1}{2} per cent., for how much must goods to the value of £5500 be insured, to cover the cost of insurance as well as the value of the goods?
- A person sells land for £835 and finds he has gained 42
 per cent.; what would his selling price be to lose 42
 per cent.?
- 10. And what percentage is the smaller of the larger price?
- 11. Find the true discount at $6\frac{2}{3}$ per cent. on £8500.
- 12. Find the present worth of £8236, 5s. due in 73 days at $4\frac{5}{5}$ per cent. per annum.
- 13. Find the present worth of £8868, 10s. due in $2\frac{1}{3}$ months at $7\frac{1}{4}$ per cent. per annum.
- Find the true discount on £8899, 8s. 9d. due in
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- 15. Find the simple interest on £8080, 8s. 8d. in $11\frac{1}{2}$ years at 7 per cent. per annum.
- 16. Find the difference between the present worth and the nominal value of £7706, 7s. 6d. due in \(\frac{1}{4}\) year at 2\(\frac{1}{2}\) per cent. per annum.

- 17. What would a banker charge for discounting a bill for £700, 10s. payable in 65 days at 5 per cent. per annum?
- 18. Express by a vulgar fraction the ratio in which the simple interest at 5 per cent. on a sum of money stands to the true discount on the same sum at the same rate and for the same time.
- 19. Express by a decimal number the relation in which the simple interest on a given sum of money in a given time at 4 per cent. per annum stands to the true discount on the same sum in double the time at double the rate per cent. per annum.
- 20. What decimal number expresses the ratio in which the true discount on a sum of money for a given time at 63 per cent. stands to banker's discount on three times the sum at two-thirds the rate per cent. for three-fifths of the time?
- 21. Express by a decimal the ratio in which the simple interest on £880 in 1 year 4 months at 3\frac{3}{2} per cent. per annum stands to the true discount on £550 due in 9 months' time at 5 per cent. per annum.
- 22. By what vulgar fraction must the simple interest on a sum of money at 10 per cent. per annum be multiplied to produce the true discount on seven times as much money for one-fifth of the time at one-third the rate per cent.?
- 23. By what decimal fraction must the present worth of a sum of money due in 1 year at 5 per cent. per annum be divided to produce its nominal value?
- 24. By what number must the simple interest on a bill for £1800 due in two months at 4 per cent. per annum be multiplied in order to produce the present worth of the bill?
- 25. If "true discount" be substituted for "simple interest" in question 24, what will the answer then be?
- 26. If "paper money" be so depreciated that a £5 note lose £1 in value, what ought to be the paper money price of a watch for which the seller will take £5 in gold?

Example XL.

If 5 men or 12 women can do a piece of work in 15 days, in how many days can 15 men and 12 women do it when they all work together?

Method.

Since 5 men do the work in 15 days, 1 man will do it in $(15 \times 5, i.s.)$ 75 days;

... 15 men will do it in (75÷15, i.e.) 5 days; And ... these 15 men do each day ‡ of the work. (1.)

Again,

The 12 women can do the work in 15 days;

... these 12 women do each day 1 of the work. . . . (2.)

Therefore, combining (1.) and (2.) we find that

the 15 men and the 12 women do each day $(\frac{1}{2} + \frac{1}{15}, i.e.) + 0$ of the work;

- ... they will do it all in (1+4, i.e.) \ day=8\ days Answer.
- N.B.—The above method will serve to solve any such problem as the one given; but a little thought will sometimes enable us to shorten this method. An example of this shortening here follows:—

The 15 men=3 groups of 5 men each The 12 women=1 group of 5 men.

... The 15 men and the 12 women together=4 groups of 5 men each.

But, by the question, we find that one of these groups could do the work in 15 days;

- . . . The 4 groups could do it in (\(\foatin\), i.e.) & days Answer.
- N.B.—A further application of this last method will be seen in the working of the next example.

Example XLI.

If 5 men or 12 women can do a piece of work in 15 days, in how many days will 12 men and 20 women do it when they all work together?

Let 5 men, or 12 women, be called 1 group of workers.

Then 12 men = $\begin{bmatrix} \frac{1}{4} & i.e. \end{bmatrix}$ 2 $\frac{2}{4}$ groups of workers and 20 women = $\begin{bmatrix} \frac{2}{4} & i.e. \end{bmatrix}$ 1 $\frac{2}{4}$ groups of workers

Therefore,

12 men + 20 women = [2] + 1], i.e] 4]; groups of workers. But one group of workers can do the work in 15 days;

... $4\frac{1}{10}$ groups can do it in $\left[\frac{15}{4\frac{1}{10}}$ i.e. $\right]$ 341 days Answer.

EXERCISE 49.

1. If 5 men or 12 women can earn a certain sum of money in 21 days, in how many days will 5 men and 12 women earn it?

2. Four men or 7 boys earn a sum of money in 11 days, in how many days will 8 men and 7 boys earn it?

3. If 6 men or 10 women can do a work in 20 days, how many days will the same work occupy 6 men and 5 women?

4. How long will it take 2 men and 9 women to do a piece of work which could be done by 4 men or 9 women in 18 days?

5. Eight horses or 13 cows are worth a certain sum of money; how many times that sum of money will be the value of 20 horses and 50 cows?

6. How long will it take 18 boys and 21 girls to earn as much money as could be earned by 5 boys or 7 girls in 33 days?

7. Two boys can earn a sum of money in 21 days; 2 girls can earn the same sum in 28 days; in how many days could the same sum be earned by the 2 boys and the 2 girls working all together?

8. Five men can earn a sum of money in 12 days; 10 girls can earn the same sum in 30 days; in how many days could the 5 men and the 10 girls earn it when working all together?

9. The wages of 12 policemen for 40 days amount to as much as would pay 20 soldiers for 72 days. How many soldiers and policemen (there being an equal number of each) would earn the same sum in 9 days?

10. The wages of 16 bricklayers for 15 days amount to the

same sum as the wages of 20 painters for 20 days. How many bricklayers and painters (there being an equal number of each) would earn the same money in 10 days?

11. If 5 men can do as much work as 7 women or 10 boys, how long will it take 5 men, 7 women, and 10 boys to do as much work as 5 men alone can do in 21 days?

12. If 7 men, 10 women, or 15 boys can perform a piece of work in 19 days, how many days will it occupy 7 men and 15 boys?

13. And in how many days could 7 men and 20 women do the same work?

14. And how long would it occupy 21 men, 30 women, and 5 boys?

15. How long will it take 2 men, 3 women, and 10 boys to do seven times as much work as can be performed by 4 men in 6 days, by 10 boys in 12 days, and by 6 women in 11 days?

16. Eight men, 13 women, or 20 boys can do a piece of work in 25 days; in how many days could the same work be done by 5 men, 20 women, and 30 boys?

17. In how many days will 6 men, 7 women, and 21 boys earn as much money as can be earned by 5 men in 30 days, by 7 women in 42 days, and 21 boys in 20 days?

18. The wages of 12 men for 5 days being the same as that of 18 women for 4 days or 30 boys for 6 days, find what equal number of boys, women, and men must be employed together to earn that amount of wages in 9 3 days.

19. The wages of 25 men for 18 days are equal to the wages of 30 women for 20 days or 100 boys for 13½ days; what is that equal number of boys, women, and men which must be employed together to earn the same amount of wages in 9 days?

20. There are three stocks, A, B, C, and it is found that £640 invested in A for 15 years (simple interest) will produce as much interest as £800 will in 12 years when invested in B, or £720 invested in C for 12½ years. What equal sums of money must be invested in A, B, and C

respectively, to produce in all as much interest in $3\frac{1}{2}\frac{1}{3}$ years as was produced by the £640 invested in stock A for the 15 years?

EXERCISE 50.

Recapitulatory and Miscellaneous.

- 1. Find the cost of 25 tons 17 cwt. 2 qr. at 17s. 6d. per cwt.
- 2. Find the cost of 16 tons 17 cwt. 1 gr. at 15s. 31d. per cwt.
- 3. Find the cost of 18 tons 13 cwt. 21 lb. at 19s. 9d. per cwt.
- 4. Find the cost of 2I tons 17 cwt. 2 qr. 10 lb. at £3, 6s. 8d. per cwt.
- 5. Find the cost of 4 yd. 1 ft. 9 in. at 17s. 8d. per yard.
- 6. Find the cost of 183 yd. at £1, 1s. 4d. per yard.
- 7. Find the cost of 99 tons 15 cwt. 2 qr. 7 lb. at £16, 5s. 8d. per cwt.
- 8. Find the cost of 69½ tons at £18½ per ton.
- 9. Find the cost of 13 cwt. 2 qr. at £7½ per cwt.
- 10. What is the value of 75½ cwt. at half-a-guinea per cwt.?
- 11. Multiply £686, 16s. $6\frac{1}{2}$ d. by $\frac{1.05}{\cdot 15}$
- 12. Divide £686, 16s. $6\frac{1}{2}$ d. by $\frac{\cdot 2}{7}$
- 13. Multiply £686, 16s. $6\frac{1}{2}$ d. by $\frac{2\cdot 1}{\cdot 4}$
- 14. Divide £686, 16s. $6\frac{1}{2}$ d. by $\frac{1}{4\cdot 2}$ Find the value of—

Find, by mental arithmetic, the value of the next ten quantities:--

31.
$$2\frac{5}{8} + 1\frac{3}{7}$$

32. $35064101 + 29$
33. $80\frac{2}{8} - 17\frac{1}{2}$
34. $2\frac{1}{7} \times 5\frac{3}{8}$
35. $18\frac{4}{1}\frac{1}{9} - 15\frac{6}{7}$

36.
$$2\frac{8}{8} - \frac{1}{3}\frac{7}{4}$$

37. 92 yd. 1 ft. 6 in. × 800
38. $8\frac{1}{2}\frac{6}{1} - 3\frac{9}{10}\frac{7}{8}$
39. $\frac{2}{9} + \frac{5}{9} + \frac{7}{8}$
40. 1700 ÷ 17 $\frac{3}{2}$

Find the value of—
41.
$$60\frac{1}{2} + 17\frac{4}{5} + 8\frac{1}{5}$$
42. $1001 - 14$ times $47\frac{1}{7}$
43. $40\frac{3}{5} \times 8\frac{1}{8}$
44. $\frac{16 - 2\frac{3}{7}}{18 \times 1\frac{4}{7}}$
48. $\frac{2\frac{1}{2} + 7\frac{5}{8}}{6\frac{3}{4} + 2\frac{4}{9} + 1\frac{1}{2}}$
49. $\frac{2\frac{1}{2} + 4\frac{1}{8}}{8\frac{3}{2} \times 4\frac{3}{7}}$
50. $\frac{6\frac{3}{8} + 3\frac{3}{5}}{6\frac{3}{8} + 3\frac{1}{9}}$
60. $\frac{41}{3}$
51. $\frac{18\frac{1}{2}\frac{7}{4} - 12\frac{13}{36}}{6\frac{3}{8} + 5\frac{5}{9}}$
61. $\frac{8}{7}$
52. $\frac{2\frac{3}{4} + 8\frac{1}{2}}{17\frac{3}{3} - 14\frac{1}{5}}$
62. $\frac{9}{9}$

63.
$$\frac{37 - 3311}{2\frac{1}{2} + 7\frac{7}{8}}$$
64.
$$\frac{6\frac{1}{2} - 2\frac{3}{8}}{16\frac{10}{3} - 7\frac{5}{8}}$$
65.
$$\frac{51 - \frac{37}{10\frac{7}{4} - 2\frac{7}{8}}}{10\frac{7}{4} - 2\frac{7}{8}}$$

66.
$$\frac{2\frac{7}{4} - 2\frac{5}{5}}{18\frac{4}{7} - 5\frac{5}{9}}$$
67.
$$\frac{18\frac{2}{7} - 3\frac{5}{6}}{20\frac{5}{9} - 18\frac{3}{4}}$$

47.
$$3\frac{3}{11} + 18\frac{2}{7} + 21\frac{1}{2}$$

7 $\frac{7}{2}$
28 $\frac{7}{8}$
68. $\frac{6\frac{5}{11} - 4\frac{3}{5}}{8\frac{3}{8} + 1\frac{1}{13}}$
69. $\frac{18\frac{1}{8} - 2\frac{5}{8}}{8\frac{3}{7} - 3\frac{5}{5}}$
70. $\frac{8\frac{3}{5} \times 2\frac{5}{7} \times 3\frac{1}{5}}{28\frac{1}{4} + 11\frac{7}{7} + 3\frac{1}{5}}$
71. $\frac{17\frac{3}{4}$ of $\frac{8}{213} + 2\frac{1}{2}$ of $\frac{1}{11}$ of $\frac{49}{6\frac{3}{5} + 4\frac{3}{11} - 2\frac{7}{10}}$
73. $\frac{17\frac{3}{5} \times 21\frac{3}{7}}{51 \times 18\frac{3}{5}}$

76. $\frac{60865 \times 40}{3 \times 3 \times 32809}$

78.
$$\frac{2\frac{1}{3} + 7\frac{8}{5}}{6\frac{2}{4} + 3\frac{1}{15}}$$
79.
$$\frac{6\frac{1}{3} \times 8\frac{4}{5} \times 2\frac{1}{19}}{3\frac{3}{5} + 6\frac{4}{7}}$$
80.
$$\frac{21\frac{1}{4} - 7\frac{5}{5}}{3\frac{1}{3} \times 7 \times 10 \cdot 5}$$
81.
$$2\frac{2}{7} + 8\frac{4}{5} + 13\frac{2}{3} + 1\frac{4}{31}$$
82.
$$3\frac{8}{3} + 4\frac{2}{5} + 3\frac{7}{9} + \frac{1}{35}$$
83.
$$4\frac{1}{3} + 8\frac{5}{1} + 7\frac{7}{9} + 1\frac{5}{35}$$
84.
$$3\frac{7}{17} + 2\frac{3}{7} + 16\frac{1}{37} + 21\frac{1}{77}$$
92.
$$10\frac{2}{5} + (16\frac{1}{10} \text{ of } 27\frac{2}{5} \text{ of } 3) + 101\frac{1}{15}$$
93.
$$21\frac{1}{7} + 3\frac{3}{3} \text{ of } 7\frac{1}{9} \text{ of } 100 + 3\frac{3}{11}$$
94.
$$17\frac{2}{4} \text{ of } 2\frac{1}{3} \text{ of } 8\frac{4}{13} + \frac{3}{17}$$
95.
$$6\frac{2}{3} \times 4\frac{3}{7} + \frac{3}{17}$$
96.
$$16\frac{2}{5} + \frac{41\frac{1}{2}}{11}$$
97.
$$\frac{3}{8} + \frac{6\frac{1}{3}}{11} + \frac{3\frac{1}{5}}{17}$$
98.
$$\frac{2\frac{1}{3} + 16\frac{3}{4} - 2\frac{1}{5}}{7}$$
100.
$$\frac{8\frac{1}{2} + 6\frac{3}{4} + 2\frac{3}{9}}{13\frac{1}{2} + \frac{3}{2}} + \frac{3}{17} \text{ of } 10$$
101.
$$\frac{3}{3} \text{ of } 2\frac{1}{5} + 2\frac{1}{3} \text{ of } 10$$
102.
$$\frac{8\frac{1}{3} + 6\frac{3}{4} + 2\frac{3}{9}}{66\frac{1}{2} - 2\frac{1}{3} \text{ of } 17\frac{1}{7} \text{ of } 50$$
103.
$$8\frac{3}{4} + 4\frac{1}{3} - 8\frac{3}{17} - 7\frac{3}{5}$$
104.
$$91\frac{7}{5} \text{ of } 8\frac{3}{3} \text{ of } 110 - \frac{21}{6} \text{ of } 20$$
105.
$$\frac{8\frac{1}{3} \times 10\frac{1}{5}}{17}$$
106.
$$\frac{8\frac{1}{3} \times 10\frac{1}{5}}{17}$$
107.
$$\frac{3\frac{1}{3} - 8\frac{2}{4}}{6\frac{3}{5} \text{ of } 8\frac{1}{3} \times 6\frac{1}{17} + \frac{3}{15} + \frac{3}{15}$$
109.
$$18\frac{3}{3} - 7\frac{5}{5} \text{ of } \frac{1}{3} \text{ of } 12\frac{5}{7}$$
110.
$$8\frac{4}{5} + 2\frac{3}{7} + \frac{1}{3} \text{ of } 66\frac{1}{3}$$
111.
$$6\frac{3}{4} + 2\frac{3}{7} + \frac{1}{3} + \frac{1}{3}$$

Express as decimal numbers—

Find the simple interest on-

152. £2200, 10s. 6d. in 7½ years at 5½ per cent. per annum.

153. £9600, 10s. in 42 years at 8 per cent. per annum.

154. £2020 in 73 years at 21 per cent. per annum.

155. £1835 in 2 years 3 months at 6½ per cent. per annum.

156. £2600, 10s. 6d. in 2½ years at 5½ per cent. per annum.

- 157. £2201, 10s. 6d. in 8 years at 5½ per cent. per annum.
- 158. £538, 18s. 6d. in $6\frac{2}{3}$ years at $4\frac{1}{3}$ per cent. per annum.
- 159. £3066 for $17\frac{1}{2}$ years at $5\frac{2}{3}$ per cent. per annum.
- 160. £1901, 10s. for $16\frac{2}{3}$ years at $5\frac{3}{7}$ per cent. per annum.
- 161. £17,382, 10s. for $4\frac{1}{2}$ years at 8 per cent. per annum.
- 162. £27,070 for 11 years at $9\frac{1}{6}$ per cent. per annum.
- 163. A thousand guineas in 17½ years at 6½ per cent. per annum.
- 164. £7500, 15s. 6d. in 18 years at 63 per cent. per annum.
- 165. £3336, 15s. 6d. in $16\frac{2}{3}$ years at $9\frac{1}{2}$ per cent. per annum.
- 166. £1369, 13s. 4d. in $6\frac{9}{5}$ years at $3\frac{9}{4}$ per cent. per annum.
- 167. £1838, 15s. 6d. in $9\frac{3}{4}$ years at $3\frac{3}{10}$ per cent. per annum. 168. £1603, 13s. 8d. for $2\frac{1}{3}$ years at $8\frac{3}{4}$ per cent. per annum.
- 169. £1708, 10s. in $3\frac{3}{4}$ years at $5\frac{1}{6}$ per cent. per annum.
- 170. £1638, 11s. in $2\frac{1}{2}$ years at $3\frac{3}{4}$ per cent. per annum.
- 171. £5058, in 2 years at 4½ per cent. per annum.
- 172. £5061, 10s. 2d. in $8\frac{1}{8}$ years at $4\frac{1}{2}$ per cent. per annum.
- 173. £1836, 16s. 1d. in 121 years at 21 per cent. per annum.

Find the amount of—

- 174. £100,600 in 53 years at 61 per cent. per annum.
- 175. £1606, 10s. 6d. in $8\frac{3}{4}$ years at $2\frac{1}{2}$ per cent. per annum.
- 176. £1809, 19s. in $5\frac{1}{2}$ years at $2\frac{2}{3}$ per cent. per annum.
- 177. £2700, 10s. in $4\frac{3}{4}$ years at $7\frac{1}{8}$ per cent. per annum.
- 178. £1909, 11s. 6d. in $1\frac{3}{4}$ years at $7\frac{1}{3}$ per cent. per annum.
- 179. £28,000 in 5 years 73 days at $6\frac{2}{3}$ per cent. per annum.
- 180. £800, 16s. 8d. in 2½ years at 3% per cent. per annum.
- 181. £2080, 10s. in 43 years at 23 per cent. per annum.
- 182. £1608, 10s. 6d. from 13th July 1871 to 29th September 1878 at 5 per cent. per annum.

Find the true discount on—

- 183. £2500, 10s. 10d. due in 2 months at 5 per cent. per annum.
- 184. £8500 due in 3 months at 43 per cent. per annum.
- 185. £808, 3s. 6d. due in 1 year at 5 per cent, per annum.
- 186. £17,017, 10s. 9d. due in 2 months at 12½ per cent. per annum.
- 187. £19,099, 10s. at $2\frac{1}{2}$ per cent.
- 188. £1707, 7s. 9d. due in 5 months at 4 per cent. per annum.

- 189. £8605, 5s. due in 4 months at 3½ per cent. per annum.
- 190. £10,886, 6s. 6d. due in ½ year at 5 per cent. per annum.
- 191. £10,608, 8s. 9d. due in $\frac{3}{4}$ year at 6 per cent. per annum.
- 192. £2050, 5s. 10d. due in $\frac{1}{4}$ year at $4\frac{1}{2}$ per cent. per annum.
- 193. £5080, 8s. due in 3½ months at 4 per cent. per annum.
- 194. £803, 10s. 8d. due in $1\frac{1}{2}$ months at 5 per cent. per annum.
- 195. £1001, 17s. 7d. due in 2½ months at 5 per cent. per annum.
- 196. £2025, 15s. due in 3 months at $6\frac{1}{2}$ per cent. per annum.

What is the present worth of—

- 197. £80,807, 7s. due in $\frac{1}{3}$ year at $4\frac{1}{3}$ per cent. per annum?
- 198. £5805, 10s. due in 3 months at $4\frac{1}{2}$ per cent. per annum?
- 199. £1550, 5s. due in 4½ months at 6 per cent. per annum?
- 200. Find the value of five times the difference between sixty tons thirteen hundredweight three quarters and one hundred tons one hundredweight two quarters and five pounds.
- 201. Find a simple fraction which expresses the relation which 6½ bears to 8¾, and multiply 35 yd. 2 ft. 7½ in. by the result.
- 202. Multiply 12 tons 15 cwt. 1 qr. 9 lb. by 19\frac{1}{2}.
- 203. The value of a clock is 6½ times that of a watch, and that of a watch is 3½ times that of a pair of boots, and a pair of boots is worth 5 pairs of slippers. The value of a pair of slippers is 2½ florins. What is the value of 3 clocks?
- 204. From 21 miles 3 fur. 20 po. 4 yd. 2 ft. take 3 miles 7 fur. 21 po. 4 yd. 2 ft. 6 in.
- 205. Divide £108, 13s. $1\frac{1}{4}$ d. by $\frac{2}{18}$.
- 206. How much must be added to 10½ guineas to give the value of 20 yards of cloth at 17s. 6d. per yard?
- 207. Find the cost of 80 tons of copper at 31 guineas a ton.
- 208. Divide 9000 guineas by 83½.
- 209. How many farthings are worth 81 yards of cloth at 19s. 3d. per yard?
- 210. From three thousand three hundred and sixty tons two quarters take nineteen hundredweight one hundred and ten pounds, and reduce the remainder to ounces.

- 211. From ten thousand yards one inch take thirty-nine yards two feet seven inches, and multiply the remainder by 99½.
- 212. How many pence are equivalent to the difference between thirty-four pounds ten shillings and threepence and sixty-thousand pounds?
- 213. Find the number of ounces which correspond to the difference between one hundred and eleven tons two quarters thirteen ounces and six thousand tons two pounds.
- 214. Find the value of £876, 16s. $1\frac{3}{4}$ d. $\times \frac{1\frac{1}{2}$ d. $\times \frac{1}{1}$ s. $1\frac{1}{2}$ d.
- 215. [£6638, 10s. 1d. £99, 19s. $0\frac{3}{4}$ d.] × $\frac{2d.}{10s. 2d.}$
- **216.** Divide 106 tons 2 cwt. by $\frac{£14, 9s.}{17s.}$
- 217. Find, by practice, the cost of 108 acres of land at an average price of £86, 14s. 7\(\frac{1}{3}\)d. per acre.
- 218. Having bought 121 acres of land for a certain sum of money, I find I have paid an average price of £82, 12s. 10 80 d. per acre. If I had invested the money at 5 per cent. per annum what would my income have been?
- 219. What is the price of coal per ton when 13 tons cost £3, 1s. 3d.?
- 220. What is the price of potatoes per ton when the cost of $1\frac{1}{2}$ ton is £11, 12s. 6d.?
- 221. What is the price of land per rood when the cost of $8\frac{s}{7}$ roods is £5 $\frac{s}{18}$ more than the cost of $3\frac{1}{16}$ roods?
- 222. What number of linear inches must be divided by 117 if the quotient is to be 63 yd. 11 in.?
- 223. How many houses at an average price of £5600, 7s. 23d. must be sold to realise £1,008,006, 10s.?
- 224. What is that number which being multiplied by 5 times itself gives 320?
- 225. What is that number which being multiplied by 3 and then divided by 261 gives 122281 17 ?
- 226. Find, by practice, the weight of 17 ploughing-machines each weighing 103 cwt. 5 lb. and reduce the result to ounces.

227. How many cwt. of zinc at £17, 19s. 3d. per cwt. must be given with £17,341, 11s. to discharge a debt of twenty thousand pounds?

Find, by practice, the value of-

228. 23 tons at £1, 3s. $6\frac{1}{3}$ d. per ton.

229. 17 houses at £163, 16s. 8d. each.

230. 271 casks of brandy at £7, 13s. 6d. each.

231. 831 yards of telegraph cable at £3, 17s. 7d. per yard.

232. 829½ sq. yds. of land at £97, 13s. 9d. per sq. yd.

233. 271 tons of beef at £18, 10s. 41d. per ton.

234. $10\frac{3}{4}$ tons of bread at £25, 6s. 4d. per ton.

235. 103 tons of cotton at £91, 18s. 8d. per ton.

236. 627 tons of hay at £11, 10s. 9d. per ton.

237. 10,600 trees at £19, 8s. 4½d. per hundred.

238. $37\frac{2}{3}$ tons of coke at £2, 10s. $5\frac{1}{4}$ d. per ton.

239. 1606 lawnmowers at £1, 18s. 9d. each.

240. 27 tons of soap at £1, 13s. 7d. per cwt.

241. 46 lb. of tea at 2s. 7d. per lb.

242. 73 cwt. 1 qr. at £2, 5s. per cwt.

243. 2 tons 8 cwt. at £69, 10s. 6d. per ton.

244. 3 tons 7 cwt. 2 qr. at 3½d. per lb.

245. 9 yd. 2 ft. 10 in. at 13s. 9d. per yd.

246. 1001 yards of cloth at 13s. 6d. an ell.

247. 28 ac. 3 po. of land at £700, 8s. 10d. per acre.

248. $91\frac{1}{3}$ at £11, 12s. 2d. each. 249. $101\frac{3}{4}$ at £6, 10s. $1\frac{1}{2}$ d. each.

250. $\frac{101}{102}$ ton at £10, 10s. $9\frac{1}{2}$ d. per ton.

Example XLII.

Divide £630 between A, B, C in such a manner that their shares shall be in the ratio of 7, 9, and 5.

Here 7+9+5=21

... out of every £21, A will get £7, B will get £9, and C will get £5.

Now £630 = 30 times 21

.. A's share will be 30 times £7, i.e., £210 B's share will be 30 times £9, i.e., £270 Answer. and C's share will be 30 times £5, i.e., £150

Example XLIII.

Divide £630 among A, B, and C in the ratios $1\frac{2}{5}$, $1\frac{4}{5}$, and 1.

(i.) It will be observed that the last example was worked by the following rule:—

Rule.

1st. Divide the given sum of money by the sum of the numbers which express the given ratios: thus—

$$\frac{£630}{7+9+5} = \frac{£630}{21} = £30.$$

2d. Multiply this quotient by the numbers which express the given ratios: thus—

£30 × 7 = £210 = A's share £30 × 9 = £270 = B's share £30 × 5 = £150 = C's share.

(ii.) The same method may be applied to the present example; thus—

 $\frac{\pounds630}{1\frac{2}{5}+1\frac{1}{5}+1} = \frac{\pounds630}{4\frac{1}{5}} = £150.$ Therefore, £150 × $1\frac{2}{5} = £210 = A$'s share and £150 × $1\frac{1}{5} = £270 = B$'s share Answer. and £150 × 1 = £150 = C's share

(iii.) But the method in this last case may be simplified, thus :-

Multiply the numbers 1²/₄, 1⁴/₅, and 1 by 5, in order to obtain three *integral* instead of three *mixed* numbers; we thus get the numbers 7, 9, and 5 to express the given ratios, and we then proceed as if these three numbers had been given to express the ratios. The answer will thus be found exactly as in the last example.

EXERCISE 51.

- 1 A man leaves £19,000 to be divided equally among 6 sons and 2 daughters; what do they each get?
- Divide ten thousand eight hundred pounds equally between 8 boys and 3 girls and state what each will get.
- 3. Divide £22,023 among 3 persons in the ratios 6, 7, 8.
- 4. Divide £2800 between A, B, C in the ratios 5, 7, 12.

- 5. Divide 1650 guineas between A, B, C, D in the proportions 2, 3, 5, 4.
- 6. Divide £18,801 in the proportions 3, $5\frac{1}{2}$, 6.

7. Divide £10,666 in the proportions $2\frac{1}{2}$, $3\frac{1}{2}$, $5\frac{1}{4}$.

8. Divide a thousand guineas in the proportions 32, 42, 5.

9. Divide £90,098, 9s. between two persons in the proportion of $3\frac{1}{5}$ and $7\frac{3}{5}$.

10. Divide £8208, 18s. between A, B, C in the ratios 2, 5, and 1.5.

Example XLIV.

Which is the greater fraction, $\frac{2}{3}$ or $\frac{7}{30}$?

1st Method.

Reduce the two fractions to the same denominator and then find the answer by inspection; thus-

$$\frac{2}{9} = \frac{20}{90}$$
and
$$\frac{7}{30} = \frac{21}{90}$$
greater because $\frac{21}{90} > \frac{29}{90}$.

2d Method.

This method is a convenient form of the first method:



 $2 \times 30 = 60$)... the fraction whose numerator is 7 is greater than the one whose numerator is 2, because the product (63) found when the 7 is one of the factors is greater than the product (60) found when the $7 \times 9 = 63$ 2 is one of the factors.

3d Method.

Reduce the two fractions to the same numerator and then find the answer by inspection: thus-

The least common multiple of 2 and 7 is 14; hence we get

and $\frac{2}{10} = \frac{14}{10}$ \(\frac{1}{10}\). the latter fraction is the greater because of two and $\frac{2}{10} = \frac{14}{10}$ \(\frac{1}{10}\) fractions having the same numerator that one is the greater whose denominator is the smaller.

N.B.—Of the above three methods the first is useful in the greatest number of cases; the second is to be preferred when, as in the above example, only two fractions are given; the last is to be applied only in particular instances such as the example here following.

Example XLV.

Which is the greater fraction, $\frac{11}{35}$ or $\frac{35}{110}$?

A hasty inspection of this example shows that the numerator of one of the fractions is a multiple of the other; it is therefore very easy to express these fractions with a common numerator; thus—

 $\begin{array}{c} \frac{11}{35} = \frac{33}{110} \\ \text{and} \begin{array}{c} \frac{3}{35} = \frac{103}{110} \\ \end{array} \end{array} \right\} \cdot \cdot \cdot \text{ by the third method of Example XLIV. we find} \\ \text{that the first of these two fractions is the} \\ \text{greater.} \end{array}$

EXERCISE 52.

Recapitulatory and Miscellaneous.

- 1. Multiply 1707 cwt. 2 qr. 10 lb. by 24½.
- 2. Multiply 3 cwt. 2 qr. 11 lb. 9 oz. by 15.
- 3. Multiply 12 tons 7 cwt. 1 qr. 19 lb. by 32.
- 4. Multiply 33 cwt. 110 lb. 6 oz. by 18 311.
- 5. Multiply 15 bush. 2 pks. by 363\\(^4\).
- 6. Multiply 3 cwt. 3 qr. 21 lb. 10 oz. by 909 3 T.
- 7. Multiply 77 miles 3 fur. 20 po. 1 yd. 9 in. by 20 13.
- 8. Multiply 16 tons 8 cwt. 101 lb. by 83.
- 9. Multiply 28 tons 19 cwt. 101 lb. by 15‡.
- 10. Multiply £90, 19s. $0\frac{3}{4}$ d. by $\frac{10\frac{1}{104}}{104}$.
- 11. Multiply 209 tons 13 cwt. 1 qr. 5 lb. by 1 1.
 12. Multiply 18 miles 7 fur. 10 po. 2 yd. by 11 1.
- 13. Multiply 6 miles 5 fur. 19 po. 3 yd. 1 ft. 7 in. by 18\frac{3}{2}.
- 14. Multiply 13 miles 3 fur. 7 po. 2 yd. 1 ft. 4 in. by 28.
- 15. Multiply 3 fur. 15 po. 2 yd. 2 ft. 3 in. by 183.
- 16. Multiply 10 miles 3 fur. 18 po. 2 yd. 2 ft. 3 in. by 27.
- 17. Multiply 98 tons 17 cwt. 1 qr. 20 lb. 3 oz. by $12\frac{1}{8}$.
- 18. Multiply 21 miles 5 fur. 3 po. 2 yd. 2 ft. 6 in. by 167.
- 19. Multiply 96 miles 3 fur. 2 yd. by 88%.
- **20.** Divide £608,723, 16s. $4\frac{1}{2}$ d. by $8\frac{4}{7}$.
- 21. Divide £603,604, 19s. 7½d. by 3½s.
- **22.** Divide £868,789, 19s. $10\frac{3}{4}$ d. by $8\frac{3}{6}$.
- 23. Divide £8,146,307, 17s. $10\frac{1}{2}$ d. by $18\frac{2}{3}$.
- 24. Divide 2908 tons 19 cwt. 2 qr. 20 lb. by 83.
- 25. Divide 9,697,909 tons 18 cwt. 17 lb. by 3%.

- 26. Divide 768,249 tons 2 cwt. 110 lb. by 82.
- 27. Divide 828,607 tons 19 cwt. 1 qr. 20 lb. by $9\frac{1}{8}$.
- 28. Divide 109,906 tons 17 cwt. 3 qr. 16 lb. by 4%.
- 29. Divide 61,382 tons 14 cwt. 1 qr. 16 lb. by 10%.
- 30. Divide £1001, 1s. 41d. by 19.
- 31. Divide £77,609, 3s. $8\frac{1}{2}$ d. by $\frac{3}{13}$
- 32. Divide 20 lb. 10 oz. 17 dwt. 20 gr. by 499.
- 33. Divide 186 lb. 7 oz. 18 dwt. 12 gr. by 47.
- 34. Multiply 23 oz. 17 dwt. 14 gr. by 7½.
- 35. Multiply £27, 19s. 61d. by 41.
- 36. Multiply £22,455, 17s. 14d. by 81/3.
- 37. Multiply £3826, 0s. 4½d. by 8¾.
- 38. Multiply £2689, 19s. 3d. by 113.
- 39. Multiply 20 tons 3 cwt. 2 qr. 10 lb. by 71.
- 40. Divide 16 miles 3 fur. 23 po. 2 yd. 7 in. by 27.
- 41. Divide 18 po. 3 yd. 2 ft. 7 in. by \(\frac{1}{6}\).
- **42.** Multiply £608,806, 16s. 6d. by $\frac{1}{73}$.
- 43. Divide 500 tons 13 cwt. 2 qr. 20 lb. $\times \frac{2}{23}$.
- **44.** Divide £53, 14s. $4\frac{1}{2}$ d. by $\frac{1}{80}$.
- 45. If $\frac{4}{5}$ of an acre of land be worth £600, 12s., what will be the value of $2\frac{4}{5}$ acres?
- 46. If I pay £846 for the simple interest on a sum of money for $\frac{2}{3}$ of a year, how much ought I to pay on the same sum of money for $6\frac{1}{2}$ years, the rate being the same in both cases?
- 47. The rent of a house for \(\frac{2}{3} \) of a year is £907, 5s.; what will be the rent of 5 such houses for 1\(\frac{1}{3} \) year each?
- 48. What will be the rent of 7 houses for 1½ year each if the rent of 1 house for 8 months be £138, 10a.?
- 49. Two-thirds of the value of a ship is £1630; what is the value of the ship?
- 50. What is that sum of money which being divided by 83 produces £45, 15s. 9\(\frac{1}{2}\)d.?
- 51. What is that sum of money $\frac{7}{9}$ of which is £6326, 14s. 8d.?
- 52. Divide 28 ac. 3 r. 30 po. of land between two men giving one of them three times as much as the other.
- 53. Divide 35 tons 15 cwt. 2 qr. 18 lb. in the proportion of 1:3.
- 54. Multiply 21 miles 3 fur. 15 po. 2 yd. 7 in. by the fraction

which expresses the relation which the multiplicand bears to one-fifteenth of itself.

- 55. Divide 16 tons 13 cwt. 1 qr. 27 lb. 11 oz. by the fraction which expresses the relation in which the product found by multiplying the dividend by 8 will stand to 3\frac{3}{5} times itself.
- 56. Find the value of $\frac{£10, 11s. 6d. \times 5\frac{3}{5} \times 7\frac{1}{7}}{4\frac{6}{11} \times 1\frac{1}{15}}$ 57. Find the value of $\frac{£25, 7s. 6d. \times 6\frac{1}{2} \times 25\frac{3}{5}}{8\frac{3}{2} \times 3\frac{1}{7}}$
- 58. Two hundred and ten gallons of rum are bought at 18s. per gallon and sold again at 30 per cent. profit. What will it cost?
- 59. A dealer buys 35 horses at £26 each, and sells them again to gain 15 per cent.; how much does he get for them?
- 60. How much will a dealer realise by the sale of 55 sheep which he bought at £7, 10s. 6d. each and now sells at a loss of 10 per cent.?

61. What will be the selling price of 58 tons of coal, bought at 25s. per ton and sold at a gain of 14½ per cent.?

62. How much will a person receive for 105 horses which he purchased at £7, 10s. each and sold again at 33\frac{1}{3} per cent. profit?

63. How much must I give for 25 yards of cloth which cost the seller 16s. 10d. per yard, and which he sells to me at a loss of 15 per cent.?

64. If coal be sold at 27s, per ton the seller will lose 10 per cent. For how much per ton must he sell it to gain 10 per cent.?

65. The selling price to lose 10 per cent. is £7, 19s. 6d.; what will be the selling price to gain 10 per cent.?

66. When £8, 10s. 4d. is received for an article the seller loses 20 per cent. For how much must he have sold it to gain 20 per cent.?

67. If a horse is worth 2 cows, and a cow is worth 5 sheep, and a sheep is worth £4, 16s.; what will be the total value of 5 horses, 5 cows, and 5 sheep?

68. If a sheep is worth £4, 5s., and a cow 3 times as much,

and a horse is worth 5 cows; what is the value of 16 horses?

69. A man exchanges 5 cows for a horse worth £65. At what price each must the other man sell the cows to gain 10 per cent. on the value of the horse?

70. If a man exchanges 3 sheep for a pony worth £17, 10s., for what sum must he sell it again to gain 18 per cent.

on its exchange value?

71. What will be the selling price to gain 15½ per cent. on an article which cost £63?

72. For what sum of money must 5 animals which cost £15, 10s. each be sold to gain 7½ per cent.?

 What will 2½ acres cost if 5 of an acre be worth £990, 18s. 9d. ?

74. If the simple interest at 32 per cent. be £8390, 18s. 9d.,

what will it amount to at 1 per cent.?

75. A gentleman sold a piece of land for £1805, 10s, and found he had thereby lost 5 per cent. on what he gave for it. For how much should he have sold it in order to gain 15 per cent. on his purchase-money?

76. If a person buys an article and sells it again at a gain of 15 per cent., receiving for it £120, 15s., how much would he have received for it if he had sold it to lose

15 per cent.

77. If a man sells articles at 7½d. each, gaining thereby 50 per cent., at what price must be have sold it to lose 20 per cent.?

78. What is the true discount on £1550 due in 2½ months, the current rate of interest being 4½ per cent. per annum?

79. What is the difference between the simple interest and the true discount on 5000 guineas in 2½ months at 2½ per cent. per annum?

80. What is that sum of money upon which the true discount at 5 per cent. for 3 months is £83, 15s. 4d.?

81. Reduce $\frac{817309642}{63}$ to a mixed number.

82. Express $314627\frac{18189}{86397}$ as an improper fraction.

83. Multiply 206.79 by 103.006.

- 84. Find the value of $\frac{65 \text{ tons } 18 \text{ cwt. } 3 \text{ qr. } 19 \text{ lb.} \times 17\frac{1}{4}}{3}$.
- 85. Express $\frac{81}{85}$ as a decimal.
- 86. What is the simple interest on £226, 10s. in $4\frac{3}{4}$ years at $7\frac{1}{8}$ per cent. per annum?
- 87. $89.69 \times 3.407 \times 6.03$.
- 88. Reduce 6s. 5d. to the fraction of a guinea.
- **89.** Reduce $1\frac{1}{8} \times 8\frac{1}{2} \times \frac{19}{8\frac{1}{8}}$ to a decimal.
- Find a decimal number equivalent to the sum of ³/₈, ⁵/₁₁, and ¹⁹/₂₄.
- 91. Multiply 21 by 019.
- 92. Express 83 as a decimal.
- 93. Multiply 29.06 by 13.25.
- 94. Express $100 \times \frac{460 + 120}{460 + 68!}$ as a decimal.
- 95. Multiply 86.017 by .20163.
- 96. Divide £28,868 among 4 persons in the ratios 2, $2\frac{1}{2}$, 5, $5\frac{1}{2}$.
- 97. Divide 9000 guineas among 5 persons in the ratios 1, $1\frac{1}{3}$, $1\frac{1}{4}$, 2, $2\frac{1}{7}$.
- Divide £70,703, 10s. among 3 persons in the ratios 10, 101, 101.
- 99. Express $\frac{3\frac{1}{8} \times 8 \cdot 5 \times 2 \cdot 2}{17 \cdot 7 \times 3 \cdot 016}$ as a vulgar fraction.
- 100. Express the following quantities as decimal numbers:— $29\frac{4}{25}; \frac{21}{101}; 74\frac{1}{4}; \frac{1}{999900}; \frac{2419}{300}; \frac{20401}{990}; \frac{9503}{90}; \frac{10099}{300}; \frac{40077}{2500}; \frac{12107}{300}.$
- 101. Express the following decimals as vulgar fractions:—
 26.072; 500.9162; .0209; 80.382; .063756; 500.91;
 20706.018.
- 102. What is the selling price to gain 10 per cent., if the selling price to lose 15 per cent. is £80?
- 103. Find the cost of 27 lb. of beef at the rate of 19 lb. for 18s. 2½d.

- 104. If a man buys a pair of boots for 16s. 8d. and sells them to lose 10 per cent., what does he get for them?
- 105. What is the compound interest on £1860 in 2 years at 41 per cent.?
- 106. A and B start on horseback to ride 200 miles. A performs the journey at an average speed of 94 miles per hour, and B at 101 miles per hour. If A start 41 hours before B, which of them will arrive at the end first, and after how long will the second one arrive?

107. Express 17.08 as a mixed number.

- 108. What is the cost of 108? acres of land at £146, 13s. 8d. per acre?
- 109. Express $\frac{65}{31}$ in the decimal notation.
- 110. Reduce 17 yd. 2 ft. 9 in. to the decimal of 19 yd.
- 111. Express 1_{19}^{6} of 1_{16}^{11} as a decimal number.
- 112. Express $\frac{85\frac{3}{11}}{7\frac{1}{8}\times16}$ as a decimal.
- 113. $3\frac{3}{7} + 8\frac{1}{5} + 16\frac{3}{11} + 2\frac{4}{5}$. 114. $8\frac{1}{2} + 10\frac{3}{13} + 20 + 14\frac{1}{8}$.
- 115. Reduce 19s. 7d. to the decimal of £1.
- 116. Divide 17.3 by 180.65 to six places of decimals.
- 117. Find the value of $\frac{70.7}{8008} \frac{7.07}{8008}$ as a vulgar fraction.
- 118. $\frac{5.5 \times 6.6}{12 \times 121}$ to a decimal.
- 119. Find, to seven places of decimals, the quotient of— $•46098 \div 40 \cdot 39011.$
- 120. Find the value of £3 $\frac{1}{8}$ + $4\frac{5}{7}$ guineas + 18 $\frac{9}{8}$ crowns + 51 florins.
- 121. Find the value of $2\frac{1}{6}$ of a mile + $3\frac{1}{6}$ fur. $36\frac{1}{7}$ poles.
- 122. Find the value of $\frac{4}{9}$ cwt. $+\frac{3}{7}$ qr. $+\frac{4}{9}$ lb.
- 123. Express by a decimal, in seven places, the relation in which 18 tons 3 cwt. 2 qr. 7 lb. stands to 20 tons 10 cwt.
- 124. Which of the following fractions is the greatest and which is the least? $-\frac{4}{17}$, $\frac{11}{13}$, $\frac{5}{19}$, $\frac{8}{29}$, $\frac{7}{16}$, $\frac{4}{17}$

- 125. A person sells a house for £500, 5s. 8d. thereby gaining 63 per cent. on what he gave for it; for how much would he have sold it to lose 63 per cent.?
- 126. Express $\frac{3\frac{3}{5} 1\frac{7}{9}}{6\frac{1}{3} \times 2\frac{1}{19}}$ as a decimal fraction.
- 127. Add together 1.8, 20.004, 101.6006, and 2.2.
- 128. Add together 14.25, 900.009, 7.62, 15.05.
- 129. Add together 2607.7, 14.005, 273.6, 4001.83.
- 130. Reduce 25 cwt. 2 qr. 10 lb. to the decimal (in six places) of 31 cwt. 3 qr. 7 lb.
- 131. How many yards of paper 33 in. wide will be required to cover a wall which is 3½ yd. long and 9½ ft. high?
- 132. How much carpet 1 ft. $10\frac{1}{2}$ in. wide will cover as much space as 101 yd. of drugget 2 ft. $1\frac{1}{2}$ in. wide?
- 133. How many cubic inches of water are contained in a tank which is 5½ ft. long, 3½ ft. wide, and 2½ ft. deep?
- 134. Find the number of cubic feet of water in a canal which is 1½ mile long, 33 yd. wide, and 12½ ft. deep?
- 135. How much paper 37 in, wide will be required to cover the walls of a room which is 18 ft. long, 15 ft. wide, and 10 ft. high, and has two windows and two doors, each window being 6 ft. 3 in. long, and 4 ft. 2 in. wide, and each door being 7 ft. 5 in. high and 4 ft. 1 in. wide?
- 136. How many yards of carpet 28 in. wide will cover as much room as 75 yd. of oil-cloth 19 in. wide? [Work this by simple proportion.]
- 137. How many square feet of carpet will be required for a room which is 6 yd. long and 4 yd. wide, and what will it cost at 2s. 6d. per sq. yd. ?
- 138. How many square inches of paper would be required to cover the walls of a room which is 20 ft. long, 15 ft. wide, and 13½ ft. high?
- 139. How many square inches are there in the floor of a room which is 13 yd. long and 5 yd. 1 ft. 6 in. broad?
- 140. How many square inches of paper will cover the walls of a room which is 17 ft. long, 14½ ft. wide, and 12% ft. high?
- 141. How many square inches are there in the ceiling of a room

whose dimensions are 10 yd. 2 ft. 3 in. by 7 yd. 2 ft. 5 in. ?

142. How much will it cost to decorate the ceiling of a room which is 12 yd. long and 10 yd. 1 ft. wide, at 2s. 9d. per square foot?

143. How much will it cost to cover a passage with oil-cloth at 2s. 6d. a square yard, if the passage be 12 yd. long and 3½ yd. wide?

- 144. What will it cost to pave a yard with flagstones at 3\frac{3}{4}\text{d}.

 per sq. ft. if the yard be 25 yd. long and 17\frac{1}{2} yd.

 wide?
- 145. How many bricks 1 ft. long and ½ ft. wide are required to cover a floor which is 8 yd. long and 5 yd. wide?
- 146. How many cubic inches of space are there in a room which is 31 ft. long, 26 ft. wide, and 4½ yd. high, and what will it cost to cover that room with carpet at 4s. 9d. per sq. yd.?
- 147. How many gallons of water did a cistern contain when full, if it was found that when two taps were running, one of which brought in 15 gallons a minute and the other took away 11½ gallons a minute, the cistern could be filled in 27 minutes?
- 148. A cistern can be filled by a tap which discharges 25 gallons a minute in 25½ minutes. How much water does it contain at a certain moment if it be found that when this tap is running and also another which can empty the cistern in 22½ minutes, the cistern is emptied in 1 hour 25 minutes?
- 149. In the last sum, how many gallons must have been in the cistern at first if after both pipes have been open 10 minutes the cistern is exactly half full?
- 150. How many yards of drugget 37 in. wide will be required for the floor of a room whose length is 5½ yd. and width 3½ yd., supposing that a space of one foot is left between the drugget and the wall all round the room?
- 151. Find, to five places of decimals, the value of-

- 152. Express by a mixed number the value of $327 \times \frac{460 + 58}{460 + 80}$.
- 153. Divide 208.36 by 1.07 to seven places of decimals.
- 154. What is the present worth of £6608, 10s. due in 7 months, interest being at 4½ per cent. per annum?
- 155. Find the value of t in each of the three following equations:—

(a.)
$$180 = 120 \times \frac{460 + t}{492}$$

(b.) $280 = 120 \times \frac{460 + t}{492}$
(c.) $960 = 720 \times \frac{460 + t}{492}$

- 156. Express $21\frac{3}{17}$ in the decimal form.
- 157. Convert 28:306 to an improper fraction in its lowest terms.
- 158. Divide £7409, 6s. 4d. among A, B, C in the proportions 3, 72, and 2.
- 159. How many square inches of paper are there on the walls of a room which is 14½ ft. long, 13½ ft. wide, 10½ ft. high, and has two windows, each of which is 5 ft. long and 3½ ft. wide?
- 160. How many square inches of paper are required to cover the walls of a room which is 21 ft. long, 5 yd. wide, and 3½ yd. high, and contains two windows, each being 7 ft. high and 4 ft. wide, and two doors, each being 7½ ft. high and 3½ ft. wide?
- 161. What is the value of $\frac{1}{3}$ of $\frac{1}{4}$ of 10 guineas?
- 162. Find, to eight places of decimals, the value of-

$$\frac{2\frac{1}{2} \times 8.56 \times 10.75}{107 + 1\frac{1}{3} + 8\frac{1}{6}}$$

- 163. Express $\frac{3\frac{8}{8}}{2\frac{1}{8}}$ as a decimal number (complete).
- 164. Express $\frac{21\frac{5}{6}}{3\frac{1}{6}}$ as a decimal number (complete).
- 165. Multiply 21 miles 5 fur. 3 po. 2 yd. 2 ft. 6 in. by 914.
- 166. Add together $8\frac{3}{5}$, $12\frac{1}{9}$, and $16\frac{16}{55}$; find the difference

between $6\frac{17}{19}$ and $11\frac{1}{3}$; and multiply the two results together.

167. Express, in ten places of decimals, the quotient of 17.653 ÷ 218.7.

168. Find the value of 13 tons 7 cwt, 2 qr. 10 lb. \div 31\frac{1}{2}.

169. Find, to two places of decimals, the square root of 7343241.

- 170. Reduce $\frac{8 \times a}{17 \times a}$ to a decimal. What difference will it make if b's be substituted for a's in this quantity?
- 171. Express, as a complete decimal number, the value of $\frac{19\frac{1}{3}}{11\frac{1}{4}}$.
- 172. What is the value of £8.625; of 14.35 tons; and of .83 of a yard?

173. Find the continued product of 16.6, 201.5, .85, and .3.

- 174. Multiply the sum of .5, 2.4, .009, and .006 by the difference between that sum and one-half of itself.
- 175. Express 23.63 and 107.06035 as improper fractions.
- 176. Find the area of a rectangular court-yard whose length is 36 ft. 3 in. and breadth 10 ft. 7 in.
- 177. What is the area of a rectangle whose dimensions are 10 yd. 2 ft. by 5 yd. 8 in.?
- 178. Find the area of a square whose side measures 10 ft. 2 in.
- 179. Find the area of a square whose side measures 101 yd. 2 ft. 10 in.
- 180. One side of a rectangle is to the other side as 3:2; find its area if the length of the shorter side be 25 ft. 10 in.
- 181. The height of a wall is to its length as 7:3. Its length is found to be equal to that of 102 ten-inch bricks. How many square inches are there in the two faces of this wall?
- 182. Find the area of a triangle whose base is 13 ft. and perpendicular height 3 ft. 7 in.
- 183. And that of a triangle whose base is 5 yd. and perpendicular height 2 yd. 9 in.
- 184. And that of a triangle whose base is 15 yd. and perpendicular height 30 ft. 3 in.

- 185. And that of a rectangle whose dimensions are 31 ft. by 7 ft. 81 in.
- 186. And of another which measures 19 ft. by 8% ft.
- 187. What is the area of a room which is 19 ft. long and 81 ft. wide; and what would it cost to colour the ceiling at 9d. per sq. ft. ?
- 188. What is the area of a triangle whose base is $3\frac{1}{4}$ yd. and whose perpendicular height is 27 yd.
- 189. Find, in a complete recurring decimal, the value of $\frac{20.45}{16.08}$.
- 190. Express $\frac{3\frac{3}{5}-2\frac{1}{2}}{7-3\frac{3}{2}}$ as a complete decimal.
- 191. How many square yards of garden are there in a rectangular enclosure which is 56 yd. long and 39 yd. wide, and has a gravel path passing down the middle of it which is 2½ yd. wide, and another crossing it at right angles which is 12 yd. wide, and having also a footpath 21 yd. wide going all round it and forming its outer limit?
- 192. Suppose a room is 72 ft. long, 55 ft. wide, and 21 ft. high, and has two doors each 11 ft. high and 91 ft. wide, and four windows each 9 ft. long and 51 ft. wide, and an oak wainscot 51 ft. high running all round the room; how many yards of paper 35 in, wide will be required to cover it, the windows being 3½ ft. from the ground?
- 193. Express the following quantities as decimals correct to ten places:-

(a.)
$$\frac{62 \cdot 7}{18 \cdot 08}$$
 (b.) $\frac{7\frac{1}{4} \times 5\frac{3}{8}}{3\frac{1}{9} \times 25\frac{5}{11}}$ (c.) $\frac{16 + 18 + 13}{19\frac{1}{19}}$ (d.) $\frac{12\frac{11}{12} + 18\frac{3}{5} + 19\frac{3}{11}}{2\frac{1}{2} + 4\frac{3}{4} + 7\frac{1}{8}}$ (e.) $\frac{9 \cdot 039 \times 2 \cdot 6}{3 \cdot 072 \times 90}$ (f.) $\frac{18\frac{1}{3} \times 10}{56\frac{3}{5} \times \frac{1}{8}}$ (g.) $\frac{8\frac{1}{2} \times 3\frac{1}{8}}{1\frac{7}{7} \times 4\frac{6}{7}}$ (h.) $\frac{6 \cdot 019}{2 \cdot 43}$ (i.) $\frac{706 \cdot 63}{8 \cdot 946}$ (j.) $\frac{27 \cdot 34}{81 \cdot 606}$ (k.) $\frac{81s \cdot 1\frac{1}{2}d}{91 \text{ guineas}}$ (l.) $\frac{29\frac{3}{11}8}{18\frac{2}{5}8}$ (m.) $\frac{81 \times 4 \cdot 7}{26 \cdot 05}$

(f.)
$$\frac{18\frac{1}{3} \times 10}{56\frac{3}{5} \times \frac{1}{8}}$$
 (g.) $\frac{8\frac{1}{2} \times 3\frac{1}{3}}{1\frac{3}{7} \times 4\frac{3}{7}}$ (h.) $\frac{6 \cdot 019}{2 \cdot 43}$ (i.) $\frac{706 \cdot 63}{8 \cdot 946}$

194. How many square inches are there in a triangle which is

10 ft. 6 in. long and 8 ft. 7 in. in perpendicular height?

195. How many square yards of land are contained in a rectangular plot which is 105 yd. 2 ft. 3 in. long and 81 yd. 2 ft. 6 in. wide, and what is its value at 5½d. per square yard?

196. If the cost of oilcloth be a farthing per sq. in., express in guineas the cost of covering a hall which is 13 ft. 4 in. long, 11 ft. 7 in. wide, and has also a triangular recess 8 ft. long and 3 ft. in perpendicular width.

197. Express $\frac{18 \text{ miles 5 fur.}}{20 \text{ miles 6 fur.}}$ as a decimal in six places.

198. Find the cost of 9 tons 19 cwt. 3 qr. 17 lb. at £1, 14s. 6d. per cwt.

199. Find, by practice, the cost of purchasing 25\frac{3}{4} acres of land valued at £8000 per acre, the cost of conveyance averaging £16, 19s. 4d. per acre.

200. Find, by practice, the cost of purchasing 9\frac{3}{4} acres of land valued at £5460 per acre, but on which a reduction of £5, 16s. 5d. per acre is made for ready cash.

201. If a herse travel for 183 hours at an average pace of 9 miles 6 fur. 24 po. per hour, find, by practice, the length of the journey it will perform in the given time.

202. What will a gentleman receive in 5 years 9 months if his annual salary is £2067, 7s. 4d.?

203. The difference between the annual incomes of two gentlemen is such that if it be multiplied by 31½ it amounts to £23,151, 12s. 3½d. The income of one of them is £800, 4s. 9d., and this is the greater of the two. What is the income of the other?

204. Find, to two places of decimals, the square root of-

(a.) 2.89 (b.) $1\frac{9}{15}$ (c.) $3\frac{1}{5}$ (d.) 20.3 (e.) 183.014.

205. Reduce the following quantities to complete decimal numbers:—

(a.)
$$\frac{21+17\frac{1}{3}}{13\cdot8}$$
 (b.) $\frac{2\frac{1}{3}\times8\frac{3}{7}}{19\frac{1}{4}\times2\frac{3}{11}}$ (c.) $\frac{40\frac{1}{5}}{50\cdot6}$ (d.) $\frac{20\cdot125}{17}$ (e.) $\frac{23\cdot3}{8\cdot5}$ (f.) $\frac{2\cdot9}{11\cdot4}$

$$(g.) \ \frac{90.9}{1.717}$$

$$(h.) \ \frac{24\frac{3}{4}}{153\frac{1}{8}}$$

(i.)
$$\frac{18\frac{1}{3} + 3\frac{1}{3} + 7\frac{1}{3}}{90 + 16\frac{3}{4} + 5\frac{1}{3}}$$

$$(j.) \frac{3\frac{2}{3}}{4\frac{1}{7}}$$

$$(k.) \quad \frac{38}{.00166}$$

$(l) \frac{933}{287}$

Example XLVI.

[Government Examination of Training Colleges—Female Students of the First Year.]

CHRISTMAS 1877.

A clock loses $1\frac{1}{2}$ minutes in 24 hours; at 12 o'clock in the day it is 2 minutes fast; when will it indicate the true time?

By the question, we see that the next day at 12 o'clock it will be only ½ min. fast.

But if it lose 1½ min. in 24 hours, it will lose one-third of 1½ min. (i.e., ½ min.) in one-third of 24 hours, i.e., in 8 hours. Therefore at 8 P.M. on the day following that on which the question opens the clock will indicate true time.

Example XLVII.

[From the same Examination Paper.]

A farmer owns 450 sheep, 90 cows, 35 horses. The value of each sheep is 2 of a cow's value; the value of each cow is 3 of a horse's value; the whole are worth £2992, 10s.; find the value of each animal.

The value of 35 horses = that of $[35 \div \dot{3}$ i.e.] 105 cows The value of 450 sheep = that of $[450 \times \dot{2}$ i.e.] 90 cows The value of 90 cows = that of

the value of all these animals=that of [105+90+90 i.e.] 285 cows.
 i.e. (by the question) £2992, 10s. = the value of 285 cows.

Therefore the value of 1 cow = $\frac{\cancel{22992}\cancel{5}}{285} = \cancel{£}10, 10s.$ and ... the value of 1 horse = \(\cancel{£}10, 10s. \times 3 = \cancel{£}31, 10s. \)
and the value of 1 sheep = \(\cancel{£}10, 10s. \div 5 = \cancel{£}2, 2s. \)

Example XLVIII.

[From the Second Year Students' Paper in the same Examination.]

A man possesses sheep, cows, and horses in numbers proportional to 90:18:7; the values of a sheep, a cow, and a horse are severally proportional to 1:5:15; and the value of all the horses is £5478, 11s. Find the value of all the sheep and all the cows.

- $1 \times 90 = 90$; and this number represents total value of sheep.
- $5 \times 18 = 90$; and this number represents total value of cows.
- 15 x 7=105; and this number represents total value of horses.

 The total values of the cheen cows and horses are several
- ... The total values of the sheep, cows, and horses are severally proportional to the numbers 90:90:105.
 - But, by the question, the value of the horses is £5478, 11s.
 ... the value of the sheep is [100 i.e.] \$ of £5478, 11s. = £4695, 18a, and, by inspection, the value of the cows is the same.

Exercise 53.

- A farmer has 35 horses, 70 cows, and 120 sheep. The
 value of a cow is 4 that of a horse, and a sheep is worth
 6 of the value of a cow. The whole are worth £3000.
 Find the value of each animal.
- 2. The values of a canary, a bullfinch, and a linnet being represented by the numbers 63, 58, and 50, find the value of each when the total value of 20 canaries, 30 bullfinches, and 42 linnets is £15, 18s. 9d.
- 3. The value of coffee is '7 of that of tea, and a pound of tea is equal in value to a pound of coffee and a pound of chicory. If 9 lb. of tea, 12 lb. of coffee, and 6 lb. of chicory together cost £3, 13s. 9d., what was the value of the coffee?
- 4. The price of a walnut tree is to that of a pear tree as 15.75: 9.75 and the price of a pear tree is to that of an apple tree as 19.5:16.5. An apple tree and a pear tree

cost exactly as much as a walnut tree and a rose tree. A nurseryman sells 1.5 times as many pear trees as walnut trees and 3 times as many rose trees as pear trees, while the number he sells of apple trees and pear trees together is to the number of rose trees and walnut trees together as 8:11. If the rose trees be eighteenpence each, and the total cost of all the trees be £40, 15a, how many trees of each sort does he buy and what is the price of each?

5. A wholesale exporter of books buys twice as many arithmetics as euclids; $2\frac{1}{2}$ as many arithmetics as algebras; and as many table books as are equal in number to the number of pence in the price of an algebra and 3 table-books. If the price of an arithmetic book be equal to $\frac{2}{3}$ that of an algebra, or to that of a euclid book and a table book together, and the cost of the whole lot be £33, 9s, what are the numbers and the prices per copy of each of the books, the total number of arithmetics

purchased being equal to the pence in the price of one and the price of a euclid book being nine times that of

- a table book?

 6. The number of first-class passengers carried by a certain train is 48 per cent. of the number of third class passengers, which again is 333½ per cent. of the number of the second-class passengers. The average numbers of miles travelled by a first, second, and third class passenger respectively are in the ratios of 1.8:2.2:2, and the fares per mile are in the ratios of 5.3:4:1.6. If the total fares by this train be £413, 6s. 8d., how much of this would be for second class passengers?
- 7. A clock loses 18 seconds per hour. At 5 P.m. on Tuesday
 I set it 10 minutes fast. When will it indicate true time?
- 8. A clock indicates true time on the 31st of July at 6 P.M.
 It then gains 5 minutes per day. When will it next indicate true time?
- 9. At what time between 6 and 7 o'clock are the hands of a watch at right angles to each other?
- 10. At what time between 3 and 4 o'clock are the hands of a watch opposite each other?

11. At what times between 7 and 8 o'clock are the hands of a watch separated from each other by an angle of 30

degrees?

12. At 2 o'clock my watch marks true time. It then begins to gain 5 minutes in every 2 hours. When will the hands (true time) be separated from each other by an

angle of 45 degrees?

13. A watch which is gaining 5 minutes per hour marks true time at 2 o'clock. At what true time will its hands be (1) opposite each other? (2) at an angle of 60 degrees from each other?

Example XLIX.

[Government Examination of Training Colleges—Female Students of the Second Year.]

CHRISTMAS 1877.

Two trains leave London, one at 7 hr. 25 min., the other at 10 hr. 10 min.: the earlier train travels at 27 miles per hour, the later train travels 42 miles per hour; at what hour, and at what distance, will the 10.10 train catch the 7.25 train?

The slow train starts (10 hr. 10 m. -7 hr. 25 m., i.e.) 2 hr. 45 m. (i.e., 2% hr.) before the fast train.

In this time it travels (27 miles × 22, i.e.) 741 miles.

The difference in the speeds of the trains, per hour, is (42-27, i.e.)15 miles.

Hence we find that the fast train overtakes the slow one at the rate of 15 miles per hour; hence, by Proportion, it will recover the 741 miles in $\frac{74\frac{1}{4}}{15}$ hr., i.e., in 4 hr. 57 m.

So that at (10 hr. 10 m. +4 hr. 57 m., i.e., 15 hr. 7 m., i.e.) 3 hr. 7 m. by the clock the one train will overtake the other. Answer.

The faster train was travelling 4 hr. 57 m. at 42 miles per hour. Therefore (42 miles $\times 457$, i.e.) 207_{10}^{*} miles is the distance from London at which the fast train overtakes the other. Answer.

Example L.

[Government Examination of Training Colleges—Male Students of the First Year.]

CHRISTMAS 1877.

Divide £7382, 2s. 2d. into two parts, so that the interest of one part for 31 years at 4 per cent. simple interest may equal the interest of the other part for 3 years at 41 per cent. simple interest.

The simple interest on any sum of money for a given number of years at a given rate per cent. is found by the formula:-

$$Simple interest = \frac{Principal \times Rate \times Time}{100}$$

Let a certain principal, P, be put out to simple interest for T years

at R per cent. per annum; and
Let another principal, P1, be put out for T1 years at R1 per cent. per annum; then

the interest on
$$P = \frac{P \times R \times T}{100}$$

and the interest on $P^1 = \frac{P^1 \times R^1 \times T^1}{100}$

so that the interest on P: the interest on $P^1 = \frac{P \times R \times T}{100} = \frac{100}{P^1 \times R^1 \times T^1}$

or (cancelling the 100) =
$$\frac{P \times R \times T}{P^1 \times R^1 \times T^1}$$

Now let P and P1 represent the two sums of money into which the given principal in the question is to be divided; then, as above,

the interest on
$$P$$
 = $P \times R \times T$ = $P \times 4 \times 3\frac{1}{2}$ = $P \times 14$ the interest on P^1 = $P^1 \times R^1 \times T^1$ = $P^1 \times 4\frac{1}{2} \times 3$ = $P \times 14$

But by the question we have

the interest on P
the interest on P¹=1
$$\therefore 1 = \frac{P \times 14}{P^1 \times 12\frac{\pi}{2}}$$
$$\therefore P^1 \times 12\frac{\pi}{2} = P \times 14$$

So that the given sum of money has to be divided into two parts in the ratio of 14 and 122.

We do this by the method of Example, and find that the result is

£3518, 11s. 6d. Answer. and £3863, 10s. 8d.

Note.—That examples of this kind resolve themselves into dividing a given sum of money into two parts which shall stand to each other as the product of one given rate per cent. x a given number of years does to the product of another given rate per cent. x a given number of years.

EXERCISE 54.*

1.* A man purchased 17 ac. 3 r. 1 po. of land; half of the land was purchased at £25 per acre; for the other half he paid £35 per acre. He sold the land for 600 guineas; what was his gain or loss?

If he had sold it for a bill for 550 guineas payable in 3 months when money was lending at 5 per cent., what percentage would he have made of gain or loss on his

outlay?

2.* The rateable value of a parish is £14,560, and a sum of £182 has to be raised by rate. How much in the pound must the rate be, and to what percentage will this be equivalent?

3.* The rental of a parish is £3200, and a net sum of £570 has to be raised by rate. Allowing for a 5 per cent. commission on the gross sum levied to the collector,

what must the rate be in the pound?

4. Four gentlemen become joint and equal guarantors to a guarantee fund of 100 guineas. Ultimately it is found that £35 only will be required, and a collector is employed to call upon these gentlemen for the money, and is paid 5 per cent. on the sum collected by him. How much does each guarantor pay, and what does the collector receive?

5. In Question 4, if the whole guarantee fund had been covered by the expenses of the undertaking, and the committee

* In this and the succeeding exercises problems will be taken from examination papers. These will be indicated by an asterisk, thus *.

of management had decided to call up the whole of the money, but had forgotten to arrange for paying the collector's fee, how much would they find themselves in debt to him at the end of the transaction?

6.* If 186 lb. of meat supply soup for 93 persons for 25 weeks, how many persons will 504 lb. supply for 9 weeks?

7. What sum of money must be put out to simple interest for 4 years at 2½ per cent, in order to give in that time a total amount of interest equal to that on £880 in 3 years

at 41 per cent?

8. A gentleman who has invested £12,000 in a business finds he has cleared 15 per cent. in his first year. In the second year his gross amount of profit is £150 less than in the first year, but as he withdrew some of his capital from the concern at the beginning of the second year he finds his actual rate per cent. has remained at 15. What amount of capital did he withdraw?

9.* Add together 3.2 of $7\frac{1}{2}$ lb., 1.6 of 15 lb., .53 of 45 lb., and

find their value at 705d. per lb.

10.* Arrange in order of magnitude (3.909 + \cdot 0909), (\cdot 0013 × 3000), ($011974 \div 003$), and find the difference between the greatest and least of them.

11.* Find a fraction which shall exceed the difference between

 $\frac{1}{7}$ and $\frac{1}{18}$ by $\frac{1}{128}$. 12.* Find the value of-

$$\frac{\frac{1}{3} - \frac{1}{5}}{\frac{1}{5} - \frac{1}{7}}$$
 of $\frac{5\frac{1}{7}}{8\frac{2}{5}}$ of $9\frac{2}{3}$ guineas.

- 13.* Three thousand one hundred guineas were divided between A, B, and C; A receives 3 of B's share, which is 2 of the combined shares of B and C. What sum did each receive?
- 14.* A man died worth £11,000. He had two sons, three daughters, and a niece. To each daughter he left half as much again as to each of his sons, and to his niece 5 of a daughter's share. How much money was left to each?
- 15. When I was 10 years old my father made a will dividing his property between my brother who was 12 years old,

my sister who was 15 years old, and me, in the ratios of our respective ages when he should die. Two years afterwards he died, and his property, which had not changed in value in the meantime, was then divided according to our ages at that time, and my share amounted to £14 more than it would have done had my father died when he made his will. How much money did he leave to be divided amongst us?

16. Divide £500 into two parts which shall stand to each other in the ratio in which the simple interest on it in 5 years at 5 per cent. would stand to its true discount in 3

months at 12½ per cent.

17. Find the present worth of £860 due in 2 months at 3\frac{1}{3} per cent., and divide it into two portions which shall be to each other in the same ratio that this present worth bears to the true discount on the £860.

18.* A newspaper boy gives 9d. a dozen for the daily papers, and sells them at 1d. each; his sale averages 100 a day for each day in the week. What percentage does he make by his purchases, and how much does he earn weekly?

19.* How long must 17 men work, after 22 men have worked for 15 days, to complete a piece of work which 29 men

could do in 19 days?

20. If 3.79 of 45 guineas will purchase 12 acres of land, how many roods will 1 of £538, 13s. purchase?

Exercise 55.

1.* A completes a work in 7½ hours, B in 12½ hours, and C in 17½ hours; what would be the time required if they worked together?

2. A can earn a sum of money in 11 weeks, B in 21 weeks, and C in 14 weeks. If they all work together, how long will it take them to earn 3 times that sum of money?

 Three men, X, Y, and Z, can build a wall in 20, 25, and 30 days respectively. X commences the work, and after 4 days is joined by Y, and to these Z joins himself after 4 other days. How many days will X spend upon the work altogether?

- 4. Two men working together can perform a piece of work in 40 days; two women can do it in 50 days, and a boy and a man can do it in 60 days. How long would the job occupy a man, a woman, and a boy working all together?
- 5. A pound of canary seed will serve a canary 25 days, or a goldfinch 20 days, or a linnet 18 days. How much seed will last 5 canaries, 5 goldfinches, and a linnet for 21 days?
- And how long would 3 lb. of seed serve 2 canaries, 2 linnets, and a goldfinch?
- 7. The same money which would keep 9 horses for 42 days would keep 7 cows for 100 days or 12 mules 50 days. I put aside sufficient money to keep 27 horses for 84 days, and with this money I keep 7 horses for 30 days, and then sell them and buy 10 cows and 8 mules; how long could I keep these with the remainder of the money?
- 8.* A pound avoirdupois contains 7000 grains, and a pound troy contains 5760 grains. Find, to three figures of decimals, how many ounces troy are contained in the pound avoirdupois, and how many ounces avoirdupois are contained in a pound troy.
- 9.* A has 47 guineas more than B, B 90 guineas more than C; C has 50 guineas less than D, D half as much as A; find what B and C have in threepenny pieces.
- 10.* A train, consisting of 44 carriages, each 4 yd. long, is travelling at the rate of 55½ miles per hour; it passes a man walking in 6 seconds; which way is the man walking, and at what rate?
- 11. A train, consisting of 11 carriages and a horsebox, travelling at the rate of 48³/₄ miles per hour, passes another train, also in motion, in 24⁶/₁₁ seconds. If the length of each carriage be 5¹/₂ yd., and that of the horsebox 4¹/₂ yd., in what direction and at what speed was the second train moving if its length was 30 ft. ?
- 12. A train consisting of 13 carriages, and travelling at 32 miles

per hour, passes another train consisting of 25 similar carriages, and travelling at 35 miles per hour, in an opposite direction, in $6\frac{19748}{3948}$ seconds. What was the

length of the carriages?

13. Two trains, one consisting of 13 carriages, and travelling at 48 miles per hour, and the other consisting of 26 cattle trucks and a luggage van, and travelling at 15 miles per hour, pass each other when travelling in the same direction in 16 121 seconds. If each carriage be 61 yd. long, and each cattle truck be 62 yd. long, what is the length of the luggage van?

14.* A and B spend £32 each on a holiday trip; each travels 20 miles per day; A's holiday lasts 40 days, and he spends 12s. 8d. per day in hotels; how long will B's holiday last if he spends 9s. 2d. per day in hotels, and

his travelling costs 1d. per mile more than A's?

15. I take up 25 shares at £1 each in a stationery company, but am only called upon to pay up one-half the subscribed capital. At the end of a year I receive 10s. dividend. What percentage on my money does this amount to?

16.* B can beat A by half a mile in a course of 4 miles, C can beat B by two minutes and A by one mile over the same course; find the rate per hour of A, B, and C.

17.* How many times must the difference between $\frac{3}{7}$ of $4\frac{1}{4}$ and $\frac{5}{8}$ of $9\frac{1}{8}$ be multiplied by $3\frac{1}{8}$ to make it equal to $\frac{1}{2}$

of 4½?

18.* State the rule for division of decimals.

Illustrate by a diagram that 36 ÷ 9 = 4.

Divide £75,308, 6s. 8d. by .007.

19.* Show by division of a line in what sense '6 can be said to be equal to \{\bar{3}\}.

Reduce 18, 5005 to circulating decimals, and 146,

·29029 to vulgar fractions.

20.* If a property be divided into four shares which are to each other in the ratios \(\frac{3}{2}:3:4\frac{1}{2}:5\frac{1}{2}\), and the third share =\(\xi\)2789, 5s. 3d., what is the value of the whole property?

Example LI.

[Government Examination of Training Colleges—Femals Students of the Second Year. Christmas 1880.]

A soldier has 5 hours' leave of absence: how far may he travel in a coach which goes 10 miles an hour, to return to camp in time, walking four miles an hour?

The rate at which he travels from the camp $= \frac{10}{4}$

and therefore

the time spent in travelling from the camp $=\frac{4}{10}$

We therefore divide 5 hours into two periods, which shall be to each other as 4:10.

By the method of Example XLIII., we find these periods are ψ hr. and ψ hr.

... The Answer = 10 miles $\times \psi = 14\%$ miles.

Example LII.

[From the same Examination Paper.]

Divide £2, 15s. among A, B, and C, so that for each threepenny piece received by A, B may receive a fourpenny piece; and that there shall be as many shillings in the sum received by C as there are sixpences in the sum received by B.

If B receives sixpence, C receives a shilling, i.e., twice as much. . . if B receives 4d., C receives 8d.

But when B receives 4d., A receives 3d.

... The shares of A, B, and C are to each other as 3d., 4d., and 8d.

By the method of Example XLII., therefore,

A's share = 11s. B's share = 14s. 8d. Answer. C's share = 29s. 4d.

Example LIII.

[From the same Examination Paper.]

If 12 ounces of bread are sold for 4d, when wheat is £6, 13s. 4d. a load, what must have been the price of wheat per load when 8 ounces of bread cost 6d. ?

When 12 ounces of bread cost 4d., the price per ounce $=\frac{4d}{10} = \frac{1}{10}$

When 8 ounces of bread cost 6d., the price per ounce $=\frac{6d.}{9} = \frac{2}{3}d.$

But, we assume from the question that the price of a loaf varies directly as the price of wheat; we thus find

id. : id. :: the price of wheat when identified the price of wheat when identified the identified the price of wheat when identified the identified the

that is. d. : 2d. :: £6, 13s. 4d. : Answer.

... Answer = $\frac{\pounds 6\frac{3}{3} \times \frac{3}{4}}{\frac{1}{3}} = \pounds 15$.

Example LIV.

[From the same Examination Paper.]

If the penny-a-mile railway fare be 40 per cent. below secondclass fare, and the second-class fare be 30 per cent, below the

The price of a loaf does not, in practice, vary directly as the price of wheat, for the price of a loaf contains-

¹st. The cost of the materials;

ad. The cost of labour;

3d. The cost of labour;

3d. The interest on capital;

and a rise in the price of wheat does not always involve a corresponding rise in the
second and third of these items; indeed, they often fall in consequence. Besides,
when wheat becomes dear, other materials will be used for making bread, and thus even the first of the three items may possibly not rise in the same ratio as the price of wheat

In Arithmetical Exercises things are, in this way, continually being assumed as true which are not quite true to the facts. Though this is quite legitimate for the immediate purpose of finding results on certain assumptions either stated or understood, the student abould be on his guard against taking these assumptions for statements of absolute facts.

first-class, and if return tickets are issued at a fare and threequarters, what ought to be the price of a first-class return ticket for 250 miles?

The penny-a-mile (single fare) would be 250d.
But this fare is 40 per cent. below the second-class fare;
... the second-class single fare = \partial 0 of 250d.
Again, this fare is 30 per cent. below the first-class fare;
... the first-class single fare = \partial 0 of (\partial 0 of 250d.).
And, therefore,

the first-class return fare = 12 of $\frac{199}{4}$ of $\frac{199}{4}$ of 250d. = £4, 6a, 93d. Answer.

Example LV.

[From the same Examination Paper.]

How many prints of an engraving must a publisher sell, at a guinea and a half each, in order to gain $51\frac{1}{5}$ per cent. on an outlay of £250 \$

In order to work this sum at all, we must assume that the £250 was spent in buying the prints now again to be sold.

Now a gain of $51\frac{1}{6}$ per cent. on £250 = $\frac{51\frac{1}{6}}{100}$ of £250.

And the net receipts will be $\frac{100+51\frac{1}{2}}{100}$ of £250 = $\frac{151\frac{1}{2}}{100}$ of £250.

But this sum is received on the sale of engravings at (a guinea and a half, i.e., at) £1, 11s. 6d. each.

... The number of engravings = $\frac{\frac{151\frac{1}{4}}{100} \text{ of £250}}{£1, 11s, 6d.} = 240 \text{ Answer.}$

Example LVI.

[Government Examination of Training Colleges—Male Students of the First Year. CHRISTMAS 1877.]

How many gallons of wine at 11s. 2d. per gallon must be mixed with 533 gallons at 15s. per gallon to gain 20 per cent. when the mixture is sold at 17s. 6d. per gallon?

Since 17s. 6d. is the price per gallon to gain 20 per cent., the cost price $=\frac{1}{1}$ of 17s. 6d. =14s. 7d.

The question may therefore be rendered thus-

How many gallons of wine at 11s. 2d. per gallon must be mixed with 533 gallons at 15s. per gallon to produce a mixture the average value of which is 14s. 7d. per gallon?

- (i.) By mixing the 533 gallons of 15s. wine and then selling it at 14s. 7d. per gallon we shall lose altogether 5d. × 533.
- (ii.) By mixing the 11s. 2d. wine and selling it at 14s. 7d. we shall gain (3s. 5d., i.e.) 41d. per gallon.
- (iii.) But the gain and the loss must be equal;
 - ... the number of gallons at 11s. 2d. = $\frac{5d. \times 533}{41d.}$ =65 Annor.

Example LVII.

[London University Matriculation Examination. June 1880.]

A plot of land is sold at £1200 per acre. What is the price in francs per square metre?

- (i.) Assuming that £1=25 francs, we find that £1200=25 francs × 1200. (A).
 - (ii.) An acre = 4840 sq. yd. = $[4840 \times 9]$ sq. ft. = $[4840 \times 9 \times 144]$ sq. in.
 - ... By the question, we find that
 the price of [4840 × 9 × 144] sq. in. = 25 francs × 1200.
 - ... By (A) we get, the price of 1 sq. in. = $\frac{25 \text{ francs} \times 1200}{4840 \times 9 \times 144}$. (B).
 - (iii.) Assuming that a metre = 39\frac{1}{2} inches, we find that 1 square metre = [39\frac{1}{2} \times 39\frac{1}{2}] sq. in. (C). . . . By (B) we find that
 - the price of 1 square metre = $\frac{25 \text{ francs} \times 1200}{4840 \times 9 \times 144} \times [39\$ \times 39\$]$ (D).

 $= \frac{25 \times 1200 \times 315 \times 315}{4840 \times 9 \times 144 \times 8 \times 8}$ francs = 7-415 francs+, Answer.

- N.B.—In the working of Example LVII. the student will notice—

 1st. That the quantities A, B, C are not converted into
 simple expressions, but are all combined into the one
 quantity D.
 - 2d. That we have thus but one conversion to perform, viz., the conversion of D into the answer.
 - 3d. That the value of the exercises exemplified in Examples XIV. and XVI. becomes very great indeed.

Example LVIII.

[London University Matriculation Examination. June 1880.]

A reduction of 30 per cent. in the price of eggs would enable a purchaser to obtain 54 more for a guinea. What may the present price be?

At present 1 guinea buys as many as $\frac{1}{10}$ guinea would after the reduction in price; or, 10 guineas now buy as many as 7 guineas would after the reduction in price;

 $\frac{\text{number bought now for 1 guinea}}{\text{number bought for 1 guinea after the reduction in price}} = \frac{7}{10}$

i.e. $\frac{\text{number bought now for 1 guines}}{\text{number bought now for 1 guines} + 54} = \frac{7}{10}$

 $\cdot \cdot \cdot 7$ (No. bought now for 1 g. +54)=10 (No. bought now for 1 g.)

 $\cdot \cdot \cdot 7 \times 54 = 3$ (number bought now for 1 guinea) $\cdot \cdot \cdot \cdot 378 = 3$ (number bought now for 1 guinea)

- 126=number now bought for [1 guinea, i.e.], 252 pence
- ... $l = number now bought for \begin{bmatrix} \frac{252d}{126}, & i.e. \end{bmatrix}$ 2d.

Hence, eggs are now selling at 2d. each. Answer.

Example LIX.

[Pupil Teachers' Examination. October 1880.]

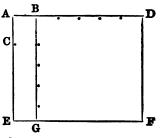
The length of a rectangular field is to its breadth as 6 is to 5. One-sixth of the field was planted, which left 625 sq. yd. for ploughing. What is the length?

In the accompanying figure
Let AB=AC,
let AD=6 times AB,
and AE=5 times AC, i.e.,5 times AB.
Then AEED represents the field

Then AEFD represents the field in question.

Through B draw BG parallel to AE; then AEGB=portion planted, and BDFG=portion ploughed=(by question) 625 sq. yd.

But BD = BG



... BD*=625 sq. yd.
... BD =
$$\sqrt{625}$$
 sq. yd.=25 yd.
and ... AB= $\frac{1}{2}$ of 25 yd.=5 yd.
and ... AD=25+5=80 yd. Assor.

Example LX.

[Civil Service Examination—Inland Revenue. MARCH 1879.]

After deducting the charge of $8\frac{3}{4}$ per cent. from a certain sum, and then a charge of $6\frac{1}{2}$ per cent. on the remainder, the result is £310, 5s. What was the original sum?

1st Method.

If £100 be reduced by 82 per cent. of itself, it becomes £911.

If this £911 be then reduced by 61 per cent. of itself, it becomes

$$\frac{93\frac{1}{8}}{100} \text{ of } £91\frac{1}{4} = £\frac{93\frac{1}{8} \times 91\frac{1}{4}}{100}.$$

Therefore,

2d Method.

Let S=answer.

Then, reasoning as in the 1st method, we find that

$$8 \times \frac{91\frac{1}{4}}{100} \times \frac{93\frac{1}{4}}{100} = £310, 5e.$$
4.e.
$$8 \times \frac{365}{400} \times \frac{187}{200} = [£310\frac{1}{4} =] £\frac{1241}{4}$$

$$\therefore 8 = £\frac{1241}{4} \times \frac{400}{365} \times \frac{200}{187} = £368\frac{1}{47}.$$

EXERCISE 56.

- *1. If 4 horses plough 45 acres in 10 days, in what time will 6 horses plough 81 acres?
- *2. The number of letters delivered in the united kingdom in the course of the year 1839 was eighty-two million four hundred and seventy thousand five hundred and ninety-six. In the following year, the penny postage being introduced, their number reached one hundred and sixty-eight million seven hundred and sixty-eight thousand three hundred and forty-four. Find, to 4 places of decimals, the increase per cent., and the gross revenue of the post-office in the latter year, at an average of 1½d. per letter.
- *3. If £1948 be gained in 5.25 years at 3 per cent, simple interest, what was the sum invested? (Answer to decimals of 1d.)
- *4. One workman receives per week .09 of £7, 10s., another .72916 of a guines. How much more will the latter have received than the former at the end of a year (52 weeks)?
- *5. An English mile is 2136 of a German mile. How long will a man, who walks 4 English miles an hour, take to walk a German mile?
- *6. If for a loan of 30s, I receive 25 of $\frac{1}{14}$ of $\frac{\frac{2}{3} + \frac{1}{3}}{\frac{3}{3} \frac{1}{3}}$ of 8 guiness, what is my interest per cent,?
- *7. Divide £177, 7s. 0\$\frac{3}{2}\text{d. among 4 persons in the proportions of \$\frac{1}{8}\$, \$\frac{1}{4}\$, \$\frac{1}{8}\$, and \$\frac{1}{8}\$.

- *8. A invests £457, 10s. at compound interest for 3 years at 4 per cent., and B £477, 10s. at simple interest for the same time at the same rate. How much more interest will the one receive than the other?
 - 9. A horse and his harness are worth £105, 6s. 8d.; the harness is worth two-thirds of the value of the horse; what is the cost of each?
- Divide £162, 8s. 9d. among three persons so that their shares shall be to each other in the proportions 3, 3, and 3.
- Divide £19, 13s. 9d. between four persons in such a manner that their shares shall be in proportion to the fractions 5, 4, and the sum and the difference of these two fractions.
- 12. Three pieces of land contain respectively \$ of 4 acres, \$ of 11 acres, and \$ of 13 acres. What vulgar fraction in its lowest terms expresses the relation in which the sum of the first and second pieces stands to the sum of the whole three?
- 13. Taking a French metre as 39:37 inches, reduce an English ell to the decimal of a French metre.
- 14. When a cistern is \$\frac{3}{7}\$ full it contains 252 gallons. Two pipes being then opened, one of which brings in 10 gallons per minute, it is found at the end of a quarter of an hour that the cistern is \$\frac{3}{2}\$ full. What is the effect per minute of the second pipe \$\frac{1}{2}\$
- 15. Two trains, the length of one being 609 feet and that of the other 843 feet, pass each other in ½ minute. The speed of one train is 20 miles per hour, what is that of the other?
- 16. What is the price of a square mile of land at 7.5 francs per square metre?
- 17. A reduction of 40 per cent. in the price of eggs enables me to buy 180 more for 7s. 6d. What is the price of eggs before the reduction?
- 18. The price of butter is so reduced that I can now get 13 lb. for the money which I have been paying for 11 lb. With £1, 9s. 3d. I can now buy 3 lb. more of butter and have 1½d. to spare. What was the price of butter per lb. before the reduction?

- 19. Nine weeks from to-day I must return from my holidays.

 I find I can save 6 guineas a week from now till I commence my holidays. If I spend on an average 13s. 6d. per day (Sundays included) while I am away, after how many days shall I have saved enough to pay my holiday expenses and bring me back to business no poorer than I now am?
- 20. If the length and breadth of a room be represented by 12 and 10 respectively, what number will express its height when the cubical contents are represented by 640?
- 21. The length of a rectangular solid is to its breadth as 9:8. Its breadth is to its depth as 8:7. If its cubical content be 648 cub. ft. what are its dimensions?
- 22. My age is to my brother's as 3.3:2.7. My brother's age is to my sister's as .54:41. What decimal expresses the relation in which my sister's age stands to mine?
- 23. The length of a rectangle is to its width as 10:7. By what fraction of itself must its length be reduced in order that the remainder may form a square with its width? If the area of the whole rectangle be 437½ sq. ft. what is its length, its width, and the area of the square of its width?
- 24. The number of square inches in the top of a perfect cube: the number of cubic inches in its volume as 12.25:42.875. Express by a vulgar fraction in its lowest terms the relation in which the number of inches in its edge stands to the number of square feet in its side. Why does this fraction differ from the value of the length of its edge the surface of its side.
- 25. The rent of one farm is £1312, 10s., that of another is £1209, 12s., and the landlord makes a reduction each year of 20 per cent. on the sum received for the first farm the previous year and 16²/₃ per cent. on that received for the second farm. After how many years will he find his income from the one farm equal to that from the other?
- 26. A room is 19 ft, long 13 ft. high and 17 ft. wide. Find

the area of its walls including windows and doors. How many cubic inches of air does it contain? If $\frac{1}{1000}$ of a cubic metre be equal to 61 027 cubic inches, express the capacity of the above room in cubic metres.

27. A grocer loses \(\frac{1}{2} \) per cent. on his sale of sugar and gains 20 per cent. on his sale of tea. He sells as much sugar as cost him £16 and as much tea as cost him £33. What is the total amount of his gain and what is his gain per cent. \(\frac{1}{2} \)

28. A grocer loses \(\frac{1}{10}\) per cent. on his sales of sugar and gains 15 per cent. on his sales of tea. What is his total profit, and what is his gain per cent. on the sale of as much sugar as he receives £12 for and as much tea as he receives £32 for !

EXERCISE 57.

*1. Make out a bill for the following:-

1 cwt. of indigo at 14s. 6d. per lb.

1 ton of cloves at 1s. 2d. per lb.

5 cwt. 3 qr. 18 lb. spelter at $4\frac{1}{2}$ d. per lb. 7 cwt. 1 qr. 14 lb. black tin at £64 per ton.

Subtract 10 per cent. discount for cash. †

*2. Divide 0.736 by 2.85 and 2.85 by 0.0736, in each case to four places of decimals, and find the product formed by multiplying the two quotients together.

*3. Find the greatest common measure and least common

multiple of 3024, 4752, and 7488.

*4. A man invests £3,600 in 3 per cent. stock at 90. He sells out at 80, and lends \(\frac{5}{8} \) of his money at 4 per cent., and \(\frac{3}{8} \) at 5 per cent. How long must the loan last, so that when he re-invests his money in 3 per cents. at 90, his gain on interest (simple) may exactly equal his loss upon principal?

*5. Seventy-five per cent. of the area of a farm is arable; of the remainder eight-five per cent. is pasture, and the rest is waste: the area of the waste is 3 ac. 20 po. What

is the area of the farm?

+ Discount is here to be reckoned as Simple Interest.

^{*} These five questions are from the Government Science and Art Examination, May 1881.

- 6. If 21 men eat 3 guineas' worth of bread in a week, what is the value of that bread which 20 men will eat in the month of December?
- 7. An inclined plane rises 17 feet in 100 yards; how many feet will it rise in 2½ miles?
- 8. If I lose 2½d. on every florin, how much do I lose per cent. If a bill for £2, 18s. be paid in florins, and 3 of them be bad ones, how much shall I ultimately gain per cent. on the goods if I had expected to gain 16 per cent. I

9. A book which is published at 16s is supplied to me for 13s. 4d., what is the mercantile discount allowed me? If I then sell it at a reduction of 25 per cent. on the published price, what shall I lose per cent. thereby?

- 10. The marked price of an article is a guinea; I buy it and am allowed 3s. discount for ready money. I keep it 6 months and then sell it again for 25s., on which I allow 5 per cent. discount for ready money. Calculating the rate of interest for the time it was in my possession at 5 per cent. per annum, what is the exact amount of my gain per cent. on the whole transaction?
- 11. A buys an article for 3s. 4d. and sells it for 4s. B buys an article for 4s. and sells it for 3s. 4d. Express by a decimal the relation which B's loss per cent. bears to A's gain per cent.
- 12. A woman buys 100 oranges at 7½d. per dozen, and 150 at 8½d. per dozen, and sells them at a 1d. each. When they are all sold she finds she has gained 6s. 6¼d. How many oranges must she have lost?
- 13. Sixty-three yards of cretonne cost £2, 9s. 10½d.; what will be the cost of each curtain if it contain ¼ yards of cretonne? and what will be the cost of 6 pairs of curtains, each equal in length to the former but the price per yard of which is 11¼/4 of that of the former?
- 14. A return of the amounts paid in respect of the grant of lafor each pupil taught singing in elementary schools for the year ended August 31, 1879, shows that the total amount paid was £128,680, 10s., in which 24,701

schools participated. How many children were paid upon as having been taught singing, and what was the average grant made to each school, and, supposing that every child in each of these schools was taught singing, what was the average attendance in each of these schools?

15. The American dollar is worth 4s. 2d. What is therefore the selling price of Gartsherrie pig iron which is quoted at 321 dollars per ton?

16. Express in American dollars the price of 7000 tons of

English steel rails at £9, 15s. per ton.

 Express the price of 9000 tons of American steel rails, at 82½ dollars per ton, as a fraction of the cost of 1200 English rails at £9, 14s. 6d. per ton.

18. The area of the Atlantic Ocean is about 9,000,000 square

leagues. Express this in square miles.

19. A metre is 39·3708 inches. The depth of the ocean in the neighbourhood of the Azores is calculated at about 10,000 metres. Express this depth in feet.

20. The difference between the selling price to gain 12½ per cent, and that to lose 13½ per cent, is £15, 5a, 8d.; what is the cost price?

21. The difference between the selling price to lose 30 per cent. and that to lose 13\frac{1}{3} per cent. is £5, 1s. 8d.; what is the selling price to gain 16 per cent.?

22. In a contested election the winning candidate with 3510 votes polled 95 per cent. above the loser. How many persons polled in this election?

23. To 08675 of 200 guineas add 675 of £250, and reduce the result to the fraction of £1000.

24. The price of tin is 87s. per cwt. for common tin, and 88s. per cwt. for refined tin. How much must the prices have risen in each case since last week, if, after deducting 5 per cent. for ready money, I paid last week £40, 2s. 9d. for 5 tons of each sort?

25. A dealer buys meat at £4, 12s. 6d. per cwt. and sells it to gain 20 per cent.; what sum of money will he gain on the sale of 1 ton? How much will he lose on each ton

of meat if his loss be 15 per cent.?

- 26. Which is the best investment, 4½ per cent, stock at 93\(\frac{3}{2}\) or 3½ per cents. at 81½; and what will be my total quarterly income on five thousand pounds invested in each?
- 27. If I invest £7700 in foreign 6 per cent, stock at 105, what shall I lose by afterwards selling out at 101 1 ?
- 28. How much stock at $87\frac{3}{5}$ can be purchased with the sum obtained by selling out £2660 stock at 81, and what difference will be made in my income if the latter pay 3 per cent. and the former $4\frac{1}{5}$?
- 29. How much stock at 99\frac{3}{5} can be purchased with the sum obtained by selling out £2850 stock at 104, and what difference will be made in my income if the former pay 3\frac{1}{5} per cent. and the latter 3\frac{1}{5}?
- 30. A person having an income of £28 per week has managed to save as much as his income would be in 13 lunar months. If he invests his money at 3½ per cent. for 3 years, compound interest, and then reinvests it in 3 per cent. consols at 91, how much will his annual income be increased or diminished at the end of the next 13 months by this transaction?
- 31. A gentleman having invested a sum of money in 3 per cent. consols at 94, afterwards sells out at 96½ and invests the proceeds in 6 per cent. Russian stock at 101. He now finds his income has been increased by £95 per quarter. How much did he invest at first?
- 32. A certain sum of money put out to simple interest at 5 per cent. will in 3 months' time amount to the present worth at that time of a bill for £5000 due in 13 months from now. What is that sum of money, true discount being calculated at 4 per cent. per annum?
- 33. An unsuccessful candidate for an election to the parliament of 1880 polled 479 votes less than the successful candidate. The total number of votes polled was 1549; how many did each candidate poll?

Example LXL

[From Pupil Teachers' Examination Paper. MAY 1881.]

A market woman sold, out of a basketful of eggs, to A one-third, less by 5, of what she had; to B, one-fifth of what she then had, less by 12; and to C, three-fourths of what she then had, less by 20. She had still 80 eggs left; how many had she at first?

1st Method.

- (i.) To C she sells [(\frac{1}{4} of what she had after her business with B) 20] and
 - after her business with C, she must therefore have (1 of what she had after her business with B) + 20 which, by the question, = 80.
 - So that we find that
 - († of what she had after her business with B)+20=80 ... † of what she had after her business with B =80-20=60 and ... the number she had after her business with B = $60 \times 4 = 240$.
- (ii.) To B she sold [(} of what she had after her business with A) 121

and after her business with B, she must therefore have had (‡ of what she had after her business with A)+12

which, by (i.) above, = 240
.: (4 of what she had after her business with A)+12=240

... $\frac{1}{2}$ of what she had after her business with A = 240 - 12 = 228.

So that

the number she had after her business with $A = \frac{1}{4}$ of 228 = 285.

(iii.) To A she sold [(1 of her eggs) - 5] and therefore

after her business with A she must have had (§ of her eggs) + 5 which, by (ii.) above = 285

.:. 1 of her eggs + 5 = 285

.. $\frac{1}{4}$ of her eggs=285-5=280 .. The number of her eggs= $\frac{1}{4}$ of 280=420 Answer.

2d Method.

Let E represent the number of eggs she had at first.

Then after her business with A she has remaining $\frac{2}{3}$ of E+5

and after her business with B she has remaining

$$\begin{array}{l} \frac{4}{5} \text{ of } (\frac{2}{3} \text{ of } E + 5) + 12 \\ = (\frac{4}{5} \text{ of } \frac{2}{3} \text{ of } E) + (\frac{1}{5} \text{ of } 5) + 12 \\ = \frac{8}{15} \text{ of } E + 4 + 12 \\ = \frac{8}{15} \text{ of } E + 16 \end{array}$$

and after her business with C she has remaining

$$\begin{array}{l} \frac{1}{4} \text{ of } (\frac{8}{15} \text{ of } E + 16) + 20 \\ = \frac{2}{15} \text{ of } E + 4 + 20 \\ = \frac{2}{15} \text{ of } E + 24. \end{array}$$

But, by the question, this is equal to 80;

.. 4 of E+24=80 ... 3 of E=80-24=56

.. E= 4 of 56=420 Answer.

Example LXII.

[From Science and Art Examination in Mathematics.

MAY 1881.]

The sides of a rectangle are 16 ft. and 10 ft. long respectively. Find, to four places of decimals, the length of a diagonal of a square whose area equals that of the rectangle.

The area of the rectangle = 16 ft. \times 10 ft. = 160 sq. ft.

.: the side of the square will be $\sqrt{160}$ sq. ft. and .: the length of the diagonal will be (by Euclid I. 47)

 $\sqrt{2} \times 160 \text{ sq. ft.}$ = $\sqrt{320 \text{ sq. ft.}} = 17.8885 \text{ ft. } Answer.$

EXERCISE 58.

- 1. From $(10.5)^2$ take $(2.7)^2$.
- 2. To $(31.3)^2$ add $\frac{1}{3}$ of $(80.5)^2$.
- 3. Multiply 60.5 by 17 times $(\frac{1}{3})^3$.
- 4. From the sum of .205, 8.03, 25.51 and (3.3)2 take 11.25 times (1.01)2.

- 5. From $(30.5)^2 + (20.4)^2$ take $(6.2)^3$.
- 6. Find the value of $(18.09 + 41.91)^2 (18.09)^2 + (41.91)^2$.
- Find the product of the sum and the difference of 0602 and 0605.
- 8. Find the product of the sum and the difference of 1 001 and 10 01.
- 9. Find the value of (018)3 and of .125 of (7.5)3.
- 10. From the square of $17\frac{1}{3}$ take the cube of $\frac{1}{17\frac{1}{2}}$.
- 11. From the cube of $\frac{3}{21\frac{3}{2}}$ take the square of $\frac{4}{28\frac{3}{2}}$.
- 12. By what number must $1\frac{17}{64}$ be multiplied to produce the cube of $\frac{3}{6}$?
- 13. By what number must 25 be divided to produce the cube of \(\frac{1}{6} \)?
- 14. What number must be added to $\frac{1}{18}$ to give 3 times the square of $\frac{1}{18}$?
- 15. What number must be multiplied by itself to produce 032?
- 16. What number must be multiplied by 3 times itself to produce 12·1203?
- 17. What is the value of 6 of that number whose square is equal to $3.4 \times 10.2 \times 5.1 \times 1.7$?
- 18. Eighteen times the cube of a certain number is equal to 0006. What is the value of 7 times the square of that number?
- 19. How many rectangular tiles 5\(\frac{1}{2}\) in. long and 4\(\frac{1}{3}\) in. wide are equal in surface to that of a room which measures 24.75 ft. by 15 ft.?
- 20. The length of a rectangle is to its width as 11:5. If the length be 36²/₃ ft., how many square feet must be added to its area to make the sum equal to the squares which may be described on its sides?
- 21. What are the dimensions of a rectangle whose sides are to each other as 19:9, and whose area is equal to that of a square whose side measures 14 ft. 3½ in.?
- 22. What is that number to which if 6 be added and the sum

be then increased by $\frac{1}{4}$ of itself and the result be afterwards increased by $\frac{2}{3}$ of itself the final result is 125?

- 23. A person having a certain sum of money increases it first by 20 per cent. and then by £2 more than 33½ per cent. of the result. He now has £218; what had he at first?
- 24. A person has a certain sum of money to which he immediately adds £23. He then invests the whole at simple interest for 3 years at 5 per cent., and then having again invested the amount in shares which bear 10 per cent. simple interest, he finds he has £138 at the end of 5 years from the date of his first investment. How much money had he at first?

25. By investing a sum of money I am able to add to it first £5 more than \(\frac{1}{12}\) of itself and then £8 more than \(\frac{7}{15}\) of the result. Invested in 3 per cent stock at \(\textit{par}\) the whole will now give me an annual income of £40, 10s. What was the original sum?

Example LXIII.

Two partners, A and B, invest £5000 and £3500 respectively in the business. A's capital has been in the concern for 9 months, and B's for 5 months, and the profit amounts to £1200. In what proportions ought this to be divided between A and B?

Assuming that the profit has increased after the manner of simple interest, that is, that it has been in uniform and direct proportion to the capital invested and to the period of investment, we find that

A's investment of £5000 for 9 months = $(£5000 \times 9, i.e.)$, £45000, for 1 month.

B's investment of £3500 for 5 months = $(£3500 \times 5, i.e.)$, £17500, for 1 month.

We have therefore to divide the profits in the ratio of 45000: 17500.

The Answer, found as in Example XLII., therefore is
£864 and £336.

Example LXIV.

A owes B £270 to be paid at the end of 3 months, £420 to be paid in 2 months, and £130 payable in 4 months. In how many months from now would a single payment of the whole of these sums fairly discharge these debts?

The following is the usual method of working such problems as this:—

- lst. Express all the sums of money and all the periods of time in units respectively of the same denominations; in the question before us this is done for us already, for all the money is expressed in pounds and all the periods of time in months.
- 2d. Multiply each sum of money by its own number of months,*
 add the products together, and divide this sum by the sum
 of the debts: the quotient is the answer.

Therefore

the Answer =
$$\frac{(270 \times 3) + (420 \times 2) + (130 \times 4)}{270 + 420 + 130}$$
 months
=
$$\frac{810 + 840 + 520}{820}$$
 months
=
$$\frac{2170}{820}$$
 months
=
$$2\frac{1}{12}$$
 months.

If therefore the sum of £820 be paid in (2\frac{2}{3} months, i.e., roughly speaking, in) 2\frac{2}{3} months, the whole of the debt will be fairly discharged.

Example LXV.

If the difference between the interest and the discount of a sum of money for 3 months at 5 per cent. be 16s. 6d. find the sum.

1st Method.

(i.) The interest on £100 in 3 months at 5 per cent. = $\frac{1}{2}$ of £5 = £1 $\frac{1}{2}$.

^{*} Or weeks or days, as the case may be.

- ... £100 put out to interest for the given time at the given rate would amount to (100+£1½=) £101½.
- ... £100 is the present worth of £1011 due in 3 months at 5 per cent.

But true discount is the difference between the present worth and the nominal value of a bill;

- ... £11 is the true discount on £1011 $\therefore \frac{\text{true discount}}{\text{nominal value}} = \frac{1\frac{1}{4}}{101\frac{1}{4}} = \frac{1}{81}$
- ... true discount $= \frac{1}{12}$ of nominal value.
- (ii.) But the simple interest on £100 in the same time at the same rate is £11;

.. simple interest =
$$\frac{1\frac{1}{4}}{100} = \frac{1}{100}$$

.. simple interest = $\frac{1}{40}$ of nominal value.

(iii.) Combining (i.) and (ii.) we thus find that

the difference between the simple interest and the true discount
$$= \frac{1}{6480} \text{ of nominal value}$$

$$= \frac{1}{6480} \text{ of nominal value}$$

$$\therefore 16s. 6d. = \frac{1}{6480} \text{ of the Answer}$$

... 16s. 6d. = $\frac{1}{8480}$ of the Answer ... Answer = 16s. 6d. × 6480

=£5846.

N.B.—In the above working

the true discount $= \frac{1}{10}$ and the simple interest $= \frac{1}{10}$ of the nominal value.

Comparing the two fractions 3 and 3 we note

1st. That they have the same numerator.

2d. That this numerator is equal to the difference of their denominators.

The same occurs in all such cases, and, by observing this, the student may often shorten his labour; e.g.

Simple interest in 4 months at 6 per cent. = $\frac{1}{16}$ of principal

... true discount for the same time at the same rate $= \frac{1}{11}$ of principal.

Again,

Simple interest in 3 months at 62 per cent = $\frac{1}{40}$ of principal ... true discount in 3 months at $6\frac{2}{3}$ per cent. $=\frac{1}{3}$ of principal.

Again.

Simple interest in $3\frac{1}{2}$ months at 5 per cent. $=\frac{1}{4\sqrt{3}}$ of principal

•: true discount in 3½ months at 5 per cent. = $\frac{7}{480+7} = \frac{7}{480+7}$ of principal.

2d Method.

The difference between the simple interest and the true discount is equal, always, to the interest on the discount:—

... 16s. 6d. is the simple interest for 3 months at 5 per cent. on the discount.

But the simple interest in 3 months at 5 per cent. $=\frac{1}{10}$ of its principal.

.: 16s. 6d.= $\frac{1}{8}$ of the discount .: discount=16s. 6d. × 80.

But, the discount in 3 months at 5 per cent. $=\frac{1}{61}$ of its principal

... the principal = discount × 81 $= 16s. 6d. \times 80 \times 81$ =£5346 A nswer.

Example LXVI.

My age is to my sister's as 8:7; my sister's age is to my brother's as 4:34; what is the ratio of my age to my brother's?

1st Method.

My age is evidently \$ of my sister's:

but her age is, as evidently $(\frac{x}{34} i.e.) \frac{25}{31}$ of my brother's;

... my age = \$ of \$\frac{2}{2}\$ of my brother's = 1 of my brother's ... my age is to my brother's as 32:25.

2d Method.

(i.)
$$\frac{\text{My age}}{\text{My sister's age}} = \frac{8}{7}$$
(ii.) $\frac{\text{My age}}{\text{My brother's age}} = \frac{3\frac{4}{7}}{4}$
(ii.) $\frac{\text{My brother's age}}{\text{My sister's age}} = \frac{3\frac{4}{7}}{4}$
And now cancelling "my sister's age," we get—

 $\frac{\text{My age}}{\text{My brother's age}} = \frac{8 \times 4}{7 \times 3\frac{4}{7}} = \frac{32}{25}$

N.B.—In the 2d Method the art is to get the quantity we wish to cancel (in this case "my sister's age"), in the second and fourth (or first and third) lines of the complex fraction.

Example LXVII.

If 18 men earn as much as 35 women, and 21 women earn as much as 40 boys, and 50 boys earn as much as 80 girls, what will be the wages of 30 men when 12 girls earn £2, 16s. 8d. ?

1st Method.

12 girls earn £2, 16s. 8d. = £25

80 girls, or 50 boys earn £24 × \$\$

and ... 40 boys, or 21 women earn £25 \times 13 \times 48

and ... 35 women, or 18 men earn £25 × \$0 × \$0 × \$1

and . 30 men carn £2 $\frac{1}{2} \times \frac{1}{12} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$

 $=\frac{£2\frac{4}{5}\times80\times40\times35\times30}{12\times50\times21\times18}.$

2d Method.

Chain Rule.

? Pounds = wages of 30 men

when the wages of 18 men = wages of 35 women

the wages of 21 women = wages of 40 boys the wages of 50 boys = wages of 80 girls

the wages of 50 boys = wages of 80 gr the wages of 12 girls =£2 $\frac{1}{2}$.

Answer

the continued product of the quantities in the right-hand column
the continued product of the quantities in the left-hand column

 $=\frac{£2\frac{4}{5}\times80\times40\times35\times30}{12\times50\times21\times18}$ (cf. Result by 1st Method)

=£41, 19s. 6,7d.

Example LXVIII.

In what proportions must beer at 36s. a barrel be mixed with beer at 45s. a barrel in order to give a mixture which may be sold at 39s. a barrel?

On each barrel of the 36s. beer, there will be a gain of 3s. and on each barrel of the 45s. beer, there will be a loss of 6s.

If therefore 3 barrels of the dearer beer be mixed with 6 gallons of

the cheaper the loss and the gain will be equal.

Therefore, the beers should be mixed in the proportion of 3 gallons of the dearer to 6 of the cheaper; in other words, there should be twice as much of the cheaper beer as there is of the dearer.

Example LXIX.

In what proportion can a master employ men at 35s. a week, women at 21s. a week, and boys at 12s. a week, so that the average pay of his work-people may be 25s. a week?

(i) Each man receives 10s. a week above the average and each woman receives 4s. a week below the average.

Therefore, as in Example LXVIII., for every 10 women he must employ 4 men.

(ii.) Again, as in (i.) above,

Each man receives 10s. a week above the average and each boy receives 13s. a week below the average.

Therefore, as in (i.) above, for every 10 boys he must employ 13 men.

(iii.) Combining (i.) and (ii.) we find that

1st. with 10 women he must employ 4 men and 2d. with 10 boys he must employ 13 men.

.: With 10 women and 10 boys he must employ (4+13, i.e.) 17 men
Answer.

Example LXX.

In what proportions may wine at 36s., 27s., and 63s. a gallon be mixed to produce a mixture which shall sell at 54s. per gallon and thereby give the vendor a profit of 12½ per cent.?

- (i.) If 54s. be the selling price to gain 12} per cent., the cost price is 48s.
- (ii.) On each gallon of the 36s. wine there is thus a gain of 12s. and on each gallon of the 27s. wine there is thus a gain of 21s. and on each gallon of the 63s. wine there is thus a loss of 15s.
 (iii.) Therefore

12 gallons at 63s. must be mixed with 15 at 36s. and 21 gallons at 63s. must be mixed with 15 at 27s.

- .. The required mixture may be found by taking 15 gallons at 36s., 15 at 27s., and (12+21, i.e.) 38 at 68s.
 - N.B.—The gains and the loss per gallon are, in this case, 12s., 21s., and 15s.

By dividing these numbers by 3 we reduce them to numbers that are prime to each other, thus

4s., 7s., and 5s.

These numbers, 4s., 7s., and 5s., may then be substituted for the 12s., 21s., and 15s. in the above working, and the answer then comes out 5 gallons at 36s., 5 gallons at 27s., and 11 gallons at 63s., and this answer is really the same as the former one, for

15:15:33=5:5:11.

Example LXXI.

Horses and cows are sold at such a price that I pay the same sum for 20 horses and 85 cows that I should for 23 horses and 78 cows. What is the comparative value of a horse and a cow? If the price in either case be £1975, what did each animal cost?

- (i.) From the question it is clear that in order to obtain 3 more horses
 I must be content to take 7 cows fewer:
 - ... the value of a horse : that of a cow :: 7 : 3; Answer.
- (ii.) A horse's value = I that of a cow
 - ... 20 horses cost as much as I of 20 cows, i.e., 461 cows
 - \cdot : 20 horses and 85 cows cost as much as $(46\frac{1}{2} + 85 =)$ 131 $\frac{1}{2}$ cows.

.. 131 $\frac{1}{4}$ cows cost £1975 and 1 cow will cost £ $\frac{1975}{131\frac{3}{4}}$ =£15 and .. 1 horse will cost $\frac{1}{4}$ of £15=£35

Example LXXII.

When my daughter was born my age was 27; when I have doubled my present age she will be $6\frac{1}{2}$ times as old as she is now. How old am I now?

27 years + my daughter's age = my present age.

But

my daughter's age + my present age = 61 times my daughter's age

... my present age = 5½ times my daughter's age. i.e., 27 years + my daughter's age = 5½ times my daughter's age.

... 27 years=41 times my daughter's age.

... my daughter's age $=\frac{27}{41}$ years =6 years.

 \cdot my present age = 27 + 6 = 88 Answer.

EXERCISE 59.

- What is that number which being multiplied by 8 of itself produces 10580?
- 2. What is that number which being multiplied by 1.6 of itself produces 360375?
- 3. What is that number which being multiplied by the square of itself is 12:169?
- 4. What is the square of that number whose cube is 296 3 ?
- What is that number which being multiplied by ¹/₈ of 4 ⁵/₈ produces unity?
- What is that number which being divided by 35 of 5.5 produces unity?
- 7. What length must be cut off a field whose width is 128½ feet to make a plot of an acre?
- 8. What is the width of a solid block of stone whose length is to its depth as 8:3, whose cubic content is 1650 cub. ft., and whose depth is 7 ft. 6 in.?
- Find the cube root of 42.875, and three times the square root of 27.5625, and express the first result as a decimal of the second.
- 10. By selling drawing-boxes at 94s. 6d. a gross the manufacturer gains 1 of the receipts. What is his gain per cent. on his outlay?
 - If he had sold them at 5 guineas per thousand, how much per cent. would he have gained?
 - Express by a fraction in its lowest terms the ratio in which the gain in the first case would stand to that in the second?
- 11. If a person lend me 13 five-pound notes when they exchange for 5 sovereigns each, how many will repay the debt when they are valued at £3, 5s. each?
- 12. From a piece of land which is $9\frac{1}{2}$ yards square what length must be cut off to form a plot which shall contain a square perch?
 - What fraction of the whole will this plot be?
- 13. What is that fraction which being divided by the cube of 2·2 and then multiplied by the square of 1·7 gives 650·25?

.14. There is a number whose square being multiplied by the cube root of $\frac{.64}{3.43}$ gives '7232142857; what is that number?

15. From the square root of \$\frac{5}{8}\$ take the cube root of \$\frac{5}{8}\$.

- 16. From the square of 21.3 take the square root of 9.86902225.
- 17. One railway station is 720 feet higher than the one next to it, which is 3½ miles distant. If the line rise uniformly all the way how many feet does it rise in 90 yards? and how far is it in yards from the first station to that point which is vertically beneath the second station and on a level with the first station?
- 18. Multiply the cube root of 000004096 by the cube of 1½.
- 19. A square contains 2652 sq. yd. 2 sq. ft. 36 sq. in.; what is the length of its side?
- 20. The weight of a certain volume of lead is to that of an equal volume of cork as 47.2:1; what volume of cork is equal in weight to that of 21 cubic inches of lead? And what weight of lead is equal in volume to that of 55 lb. of cork?
- 21. The value of a barrel of beer is to that of a cask of wine as 3.1:7; and 5 barrels of beer with 11 casks of wine cost as much as 16 casks of brandy; find the number which represents proportionally the value of a cask of brandy.
- 22. A cattle-dealer buys 700 sheep at a certain price each; they increase to 840, and he then sells them at the same price each. His expenses in the meantime amount to 13 per cent. of his outlay; what is his ultimate gain per cent.?
- 23. A certain town contains 14,168 inhabitants; after this there are 2850 births and 1990 deaths. Owing to removals from the town the actual increase is found to be reduced to 3\(\frac{4}{7}\) per cent. of the original number of inhabitants, how many removals there were?
- 24. Of the different beverages sold in one day in a coffee-palace, two-thirds are cups of tea, one-fourth are cups of coffee, and the remaining 153 cups are of cocoa. How much

did the whole cost, the tea being sold at 1½d. a cup and the coffee and the cocoa at 1d. each?

- 25. At a restaurant 20 per cent. of the dinners are fish, 52 per cent. are beef, 13 per cent. are mutton, 10 per cent. are veal, and the rest are pork. The dinners are charged 1s. 2d. each, and the receipts for pork dinners amount to £1, 4s. 6d.; what are the sums received for fish, beef, and mutton respectively?
- 26. On another occasion the beef dinners are 12½ per cent. of the whole, the mutton dinners are 40 per cent. of the whole, the fish dinners are 75 per cent. of the mutton dinners, and the remainder are veal dinners. The price of a beef dinner is to that of a mutton dinner as 7:6; a veal dinner costs 1s. 4d.; a fish dinner costs as much less than a veal dinner as it costs more than a beef dinner, and is to a veal dinner as 6½ per cent.: 63 per cent. The whole of the veal dinners cost £9, 6s. 8d. What is the cost of the beef, the mutton, and the fish dinners?
- 27. Divide 560 into two parts so that \(\frac{1}{12} \) of one part added to \(\frac{1}{2} \) of the other part shall be equal to 105.
- 28. Divide 330 into two parts so that \(\frac{1}{2} \) of one part shall be equal to \(\frac{1}{18} \) of the other.
- 29. Divide 53.9 into two parts so that $\frac{3}{10}$ of one part shall be equal to $\frac{5}{9}$ of the other.
- 30. How many inches are there respectively in the diagonal of a cubic foot, a cubic yard, and the side of a cube which contains 100 cubic feet?
- 31. The length of a table is to its width as 8:11; what are its dimensions when it is found that the sum of the squares described upon its sides = $566\frac{1}{16}$ sq. in.?
- 32. What are the dimensions of a table when the difference of the squares upon its sides amounts to 47610 sq. in., the length of one side being to that of the other as 3:13?
- 23. A rise of 8 per cent. in the price of lead-pencils enables me to purchase 32 less than before for a guinea. What is the price per dozen before reduction?

EXERCISE 60.

 A:B::7:9; and B:C::5:13; what is the ratio of A:C?

The length of a box is to its width as 18:11; its width
is to its depth as 15:11½; what is the ratio of its

depth to its length?

3. Five times the depth of a cistern is equal to eight and a half times its width, and its width multiplied by seventeen is equal to its length multiplied by two and a half. By what number must its length be divided to give its depth?

4. For every 5 soldiers there are in a colony 2 sailors, and 3:375 times the soldiers gives 1:25 times the civilians. Express, by a fraction in its lowest terms, the number of sailors there are to every 18 civilians.

5. The number of copies of the Standard newspaper sold at a railway bookstall is to the number of the Echo as 11:41, and to the number of the Times as 8:5, and to the number of the Daily News as 15:16. If no other papers are sold, what percentage of the whole are Standards?

6. The number of horses at a fair is to the number of ponies as 21:11; the ponies are to the cows as 3½:28; the cows are to the sheep as 2.2 to 20; the sheep are to the pigs as 51:5.6; what percentage of the whole are the ponies?

7. If the horses were to the sheep as 81:101, the cows to the pigs as 15:103, and there were as many sheep as cows, what was the ratio of the horses to the pigs? and what

percentage of the whole were the sheep?

8. The wages of 20 men equal those of 39 women; 40 women earn as much as 99 boys; 19 boys earn enough money to keep 5 horses for 15 weeks; it costs as much to keep 8 horses for 6 weeks as would buy 13 acres of land, and the price paid for 10 acres of land is £42, 10s. Find to the nearest sixpence the sum of money required to pay the wages of 35 men.

9. Of the stamps sold at a post-office 45 per cent. are penny

stamps, 30 per cent. are halfpenny stamps. Of the remainder, 85 per cent. are sixpenny stamps, and the rest are twopenny-halfpenny stamps. What percentages of the total receipts are received respectively for each kind of stamps?

10. For a shilling I can buy 5 tulip bulbs or 9 lilies; for 3s. 6d. I can purchase 25 geraniums or 28 fuchsias; for half-a-crown I can buy 13 dahlias or 15 verbenas. Find a series of integral numbers expressing the relative

values of a dozen of each of the plants named.

11. Find also a series of integral numbers expressing the purchasing power of any given sum of money as expressed in terms of each of the different plants named in question 10 and under the circumstances there given.

12 For 3 years in succession my salary increases 10 per cent.

on the previous year. I find however that the purchasing power of money has decreased by 10 per cent. each year on that of the year before. Show that notwithstanding this decrease in the value of money I am really better off at the end of the period than I was at its beginning, and express my relative financial position (expressed in terms of the purchasing power of money) by a vulgar fraction in its lowest terms.

13. In what proportions must I buy wheat at 15s. a sack and at 17s, a sack in order to produce a mixture which shall

cost me 16s. 3d. a sack?

14. What relative amounts of stout at 25s. for 18 gallons must be mixed with bitter beer at a guinea for 18 gallons in order that the mixture may be worth 1s. 3d. a gallon?

15. In order to sell milk at 5d. a quart and to make thereon a profit of 20 per cent., what relative proportions of milk at 1s. 6d. a gallon, at 1s. 2d. a gallon, and at 1s. 9d. a

gallon, may the dealer mix together?

16. To 21 pints of wine at 18s. a gallon, how many pints at 32s. a gallon must be added to produce a mixture the average cost of which is 28s. 6d. a gallon?

17. To 35 quarts of milk which cost 3½d. per quart, what quantities of milk at 4d. per quart, and of water, must

be added in order that the retailer may sell 5 quarts for 2s. and gain 30 per cent. on his outlay?

- 18. Seven horses and 60 cows cost as much as 12 horses and 45 cows. What are the relative prices of a horse and a cow?
- 19. The wages of 32 bricklayers and 50 labourers are the same as those of 21 bricklayers and 72 labourers. What are the comparative wages of 13 bricklayers and 13 labourers?
- 20. The weight of 40 bottles of wine and 50 bottles of brandy is equal to that of 32 bottles of wine and 60 of brandy. The weight of 7 bottles of brandy and 25 of beer is the same as that of 11 bottles of brandy and 20 of beer. What are the comparative weights of an equal number of bottles of wine and of beer?
- 21. When a gentleman's daughter was born his age was 38.

 When he has doubled his present age his daughter will
 be 44 times as old as she now is. What is her present age?
- 22. What is that number which being increased by 30 becomes 1.5 of itself greater?
- 23. There is a number which having been increased by 20 per cent. of itself is greater by 77 than it would be if it were reduced by 20 per cent. of itself. What is that number?
- 24. There is a number which being increased by 30 per cent. of itself is greater by 489 than the number found by reducing it by 30 per cent. of itself. What is that number?
- 25. When a number has been increased by 15 per cent, of itself it is found that the sum is greater by 621 than 85 per cent, of itself. What is that number?
- 26. After a number has been reduced by 13 per cent, of itself the remainder is found to be 950.04 less than that remainder increased by 13 per cent, of itself. What is that number?
- 27. If the number of the square inches in the side of a cube be multiplied by the square of the number of the inches in the edge of the cube the result is 789 0481 square inches. What is the solid content of the cube?

28. When the number of square inches in the side of a cube has been multiplied by the density of the liquid contained in the cube, the result is equal to 84 per cent. of the number of the cubic inches contained in the cube. If the density of the liquid be 1.1 what is the volume of the cube?

Example LXXIII.

My salary for two months amounts to £86, 13s. 4d.; the annual salary on which the second month's salary is reckoned is £40 more than that on which the first month's is reckoned. What are the annual salaries on which my income is computed?

The second month's salary is $(\frac{1}{12}$ of £40, i.e.) £3, 6s. 8d. more than that for the first month;

.. the first month's salary =
$$\frac{£86, 13s. 4d. - £3, 6s. 8d.}{2}$$
 (see Ex. XXXVIII.)
= $\frac{£83, 6s. 8d.}{2}$
= £41, 13s. 4d.

.: his salary in the first month is at the rate of (£41, 13s. 4d. ×12=) £500 a year, and in the second month at £540 a year. Answer.

Example LXXIV.

My income for two months is £45; the salary for the first month is reckoned on an annual income which is to that in the second month as 4:5. What is the annual income on which the salary is reckoned in the second month?

The salary in the first month: the salary in the second month:: the yearly rate during the first month: the yearly rate during the second month.

- ... The salary in the first month: the salary in the second month:: 4:5.
- .: £45 must be divided into two portions which shall stand to each other in the ratio of 4:5.
- By Example XLII., we find that these portions will be £20 and £25.

 The salary in the second month is £25 and is reckoned on a yearly income of (£25 × 12, i.e.) £300 Answer.

EXERCISE 61.

1. A person's salary rises £30 a year. His salary for the last month of one year added to that for the first month of the next year is £112, 10s. What will be his salary for the two months next following?

 A gentleman receives £120, 16s. 8d. for three months' salary; two months ago his annual salary was raised £50 a year: what will he receive at the end of the next

quarter?

3. A person's income is increased 30 per cent, and he finds that his total income for six months before the increase added to that for eighteen months after the increase amounts to £857, 10s. What did he receive for his first quarter's wages after the rise?

4. A's salary for two years is to B's for three years as 57:91; their combined salaries for the next year and a half amount to £960. What is the annual income of each

of them?

5. A's annual income is to B's annual income as 8:11; A's salary is raised 30 per cent. and is now £9 a year less than B's, which remains stationary. What is B's salary?

6. A's salary for 15 months is to B's salary for 16 months as 11.25:10.24. When B's annual salary has been increased 25 per cent. it is £50 more than A's; find their

respective annual salaries.

7. A man's salary for the first year is to his wife's as 1.6:1; at the end of the year the man receives an increase of 20 per cent. and the woman an increase of 10 per cent.; at the end of the second year the woman receives another increase of 10 per cent. on her last year's wages and the man an increase of 12½ per cent. When the third year has expired the man finds he has received £118, 10s. more than his wife. What was their joint income during the third year?

8. The amount of water in one reservoir is to that in another as 8:7; during the next day there is an income of 50 per cent. on the quantity in one of the cisterns at the beginning of that day, and an amount is then withdrawn

equal to 25 per cent. of the total then in that cistern. In the meantime the water in the smaller cistern has been first increased by 20 per cent. and then reduced by 10 per cent. of the result; the difference in the quantity of water in the respective cisterns is then found to be 36 gallons. How much did each contain at first?

- 9. $\frac{A}{B} = \frac{6 \cdot 12}{9 \cdot 3}$; A increased by 20 per cent. B increased by 20 per cent. = 55 ·65; find the values of A and B.
- 10. $\frac{A}{B} = \frac{6 \cdot 6}{6 \cdot 16}$; A increased by 10 per cent. B decreased by 10 per cent. = 21·45; find the value of $\frac{A+B}{A-B}$ as a fraction in its lowest terms.
- 11. $\frac{A+B}{A-B}=6$; A increased by 30 per cent. + B reduced by 7 per cent. = $22\frac{1}{4}$; find the value of $\frac{A\times B}{A+B}$.
- 12. $\frac{a \times b}{a+b} = 14\frac{1}{16}$; $\frac{b \times a}{b+a} = 2\frac{1}{4}$; find the value of $\frac{7a+7b}{14a-14b}$
- 13. A train starts from A to B at a speed of 23½ miles per hour. Fifty minutes later another train starts from B and arrives at A fifteen minutes before the other reaches B. The distance from A to B is 105 miles. Express by a fraction in its lowest terms the relative speeds of the two trains.
- 14. Two men swim round the circular tank of an aquarium, the one at 2½ miles an hour, the other at 2½ miles an hour. If the circumference of a circle be to its diameter as 22: 7, and the diameter of the tank be 90 feet, after how many laps will the two men come together at the starting point?
- 15. Eleven times round a certain running-ground (11 laps) are taken as a mile. Two men start to run a five-mile race there, the one takes 13 steps to the other's 12, but the length of the pace of the former is to that of the latter as 24 is to 25. Express by a vulgar fraction the relation in which the speed of the one man stands to that of the

other. Will the two men at any point in the race be both again at the starting-place at the same time? If not, by how much must the length of the race to be run be increased in order that they may both be at the starting-place together?

16. A man rows down a stream at 3½ miles per hour and returns again against the stream at 2½ miles per hour, resting 50 minutes before setting out on the return journey. He left home at 8 A.M. and returned at 3.30 P.M. At what hour did he start on the return journey?

17. Exactly at mid-day the hour hand of a clock points to 12, but the minute hand has become disordered and points to 11. At what hour will the two hands of this clock be inclined to each other at an angle of 40 degrees?

18. Of a certain number of beans planted in my garden 3 per cent. are bad, 15 per cent. of the remainder are eaten by grubs, 10 per cent. of the remainder are trodden down by cats, and 5 per cent. of the rest are removed by the gardener. The rest grow and bring fruit thirteenfold. After setting aside 4 per cent. of these as seed I find I have 21 pecks to dispose of. How many pecks did I plant?

Example LXXV.

[London Matriculation Examination. June 1881.]

Water runs into a cistern by one pipe and from it by two, in each pipe at a uniform rate when the pipe is open. The cistern holds 1000 gallons. If all three pipes be open at once, the cistern, supposed full, would empty itself in 200 minutes. If one escape pipe and the supply pipe be open, it would, if empty, fill in 200 minutes. But if the other escape pipe and the supply pipe be open, in 100 minutes. How long would it take the two escape pipes to empty the cistern if the supply pipe were closed?

(1.) When all the pipes are open, 1000 gallons are removed in 200 minutes;

... the loss per minute is 5 gallons.

But, if the cistern be empty and one escape pipe closed, it will fill again in 200 minutes;

... in this case, the gain per minute is 5 gallons.

... when opened, this pipe must remove I0 gallons per minute.

- (2.) When this pipe is opened and the other escape pipe closed, the cistern is filled in 100 minutes;
 - ... the gain per minute is 10 gallons.

But, when the two escape pipes are opened as well as the supply pipe, there is a loss of 5 gallons per minute.

. . . the other escape pipe must remove 15 gallons per minute.

(3.) The two escape pipes together remove [15+10=] 25 gallons per minute,

and would therefore empty the cistern of 1000 gallons in $\left[\frac{1000}{25}\right]$ 40 minutes. Answer.

Example LXXVI.

In what proportions may wine at 36s. a gallon be mixed with wine at 48s. and with water, in order to produce a mixture worth 25s. 6d. a gallon?

1st Method.

- (i.) On each gallon of the wine at 36s, there is a loss of 10 ls.

 On each gallon of the water there is a gain of 25 ls.

 251 callon of wine at 26s must be nized with 101 of water
 - .. 25½ gallons of wine at 36s. must be mixed with 10½ of water.
- (ii.) On each gallon of the wine at 48s, there is a loss of 22½s. On each gallon of the water there is a gain of 25½s.
 - ... 25½ gallons of wine at 48s. must be mixed with 22½ of water.
- (iii.).. With 25½ gallons of wine at 36s. and 25½ gallons at 48s. there must be mixed [10½ + 22½ =] 33 of water

The quantities thus become 25½: 25½: 33

or 51 : 51 : 66 or 17 : 17 : 22.

2d Method.

(i.) If a mixture which contains wine at 36s. per gallon and water, be worth 25s. 6d. per gallon, how much of it is wine?

Answer, $\frac{25\frac{1}{3}}{36}$ of it; i.e., $\frac{25\frac{1}{3}}{36}$ of 1 gallon; i.e., $\frac{17}{24}$ of it

.: out of 24 gallons of the mixture, 17 will be wine at 36s. and 7 will be water.

(ii.) If a mixture which contains wine at 48s. per gallon and water, be worth 25s. 6d. per gallon, how much of it is wine?

Answer,
$$\frac{25\frac{1}{48}}{48}$$
 of it; i.e., $\frac{25\frac{1}{48}}{48}$ of 1 gallon = $\frac{17}{32}$ of it

- ... out of 32 gallons of the mixture, 17 will be wine at 48s, and 15 will be water.
- (iii.) Adding together the quantities found in (i.) and (ii.) we get the final result, viz., 17 at 36s.

 17 at 48s.

 [7+15=] 22 of water

8d Method.

Suppose any quantities of the two wines to be taken, say 5 gallons at 36s. and 9 gallons at 48s.; find how much water must be added to reduce the mixture to 25s. 6d. a gallon.

- (i.) $\begin{array}{c} 5 \text{ gallons at 36s. per gallon cost } \pounds 9, \quad 0s. \\ 9 \text{ gallons at 48s. per gallon cost } \pounds 21, \quad 12s. \\ \hline \text{Total, } \hline 14 \text{ gallons} & \cos \pounds 20, \quad 12s. \\ \end{array}$
 - \therefore average cost per gallon = $\frac{£30, 128.}{14}$ = 43‡s.
- (ii.) If a mixture which contains wine at an average cost of 43‡s. per gallon and water, be worth 25s. 6d. per gallon, how much of it is wine?

Answer,
$$\frac{25\frac{1}{2}}{43\frac{5}{2}}$$
 of it; *i.e.*, $\frac{7}{12}$ of it

- ... out of 12 gallons of the mixture 7 are wine and 5 are water;
 - i.e. 5 gallons of water are put with 7 of wine; or 10 gallons of water are put with 14 of wine.
- (iii.) But, by (i.) we find that of the 14 gallons of wine, 5 will be worth 36s. a gallon and 9 will be worth 48s. a gallon;

N.B.—It will thus be seen that there is more than one possible answer to these questions. It should also be noted that the First and Second Methods give equal quantities of the different wines, and the Third Method gives unequal quantities.

Example LXXVII.

If 13 ounces avoirdupois cost £1, 2s. 1d., how much should 13 ounces troy of the same commodity cost?

1st Method.

The question may now be put thus-

If 56874 grains troy cost £1, 2s. 1d., what will be the cost of 6240 grains troy?

By proportion, we get

.: Answer=
$$\frac{£1, 2s. 1d. \times 6240}{5687\frac{1}{8}}$$
=£1, 4s. $2\frac{36}{3}$ d.

2d Method.

In the question the number of ounces avoirdupois is the same as the number of ounces troy;

we may therefore neglect the 13 in each case, and proceed as though it was 1 ounce in each case;

now 1 oz. avoir.
$$=\frac{7000}{16}$$
 grains troy,

and 1 os. troy =
$$\frac{5760}{12}$$
 grains troy.

Therefore.

$$\frac{7000}{16}:\frac{5760}{12}::$$
£1, 2s. 1d. : Answer.

.: Answer =
$$\frac{£1, 2s. 1d. \times 5760 \times 16}{12 \times 7000} = £1, 4s. 2\frac{24}{11}d.$$

Example LXXVIII.

In assaying silver ore, the percentage of metal is 75; how many ounces to the ton is this?

Out of 100 oz. of ore, '75 oz. will be silver. ... out of 1 oz. of ore, '0075 oz. will be silver.

A ton contains 35840 ounces,

... out of 1 ton of ore there will be 0075 oz. × 35840, i.e., 268.8 oz. Answer.

Example LXXIX.

The average of fourteen numbers is $8\frac{18}{18}$; that of the first four is $5\frac{1}{2}$, that of the next seven is $10\frac{3}{4}$, what is that of the remaining three?

The sum of the fourteen numbers = $8\frac{181}{8} \times 14 = 122\frac{11}{4}$. Now, that of the first four = $5\frac{1}{8} \times 4 = 22$

and that of the next seven = $10\frac{\pi}{2} \times 7 = 75\frac{\pi}{2}$. Adding together these, we find that the sum of the first eleven numbers = $22 + 75\frac{\pi}{2} = 97\frac{\pi}{2}$,

and ... that of the remaining three = $122\frac{11}{12} - 97\frac{3}{4} = 25\frac{1}{6}$,

and ... their average = $\frac{25t}{3} = 8\frac{7}{18}$ Answer.

Example LXXX.

The average of fourteen numbers is $22\frac{1}{2}$, that of the first five being one-half that of the next three and one and one-half that of the remaining six; what was the average of the first eight?

If the average of the first five be 1, that of the next three will be 2, and that of the remaining six will be \(\frac{2}{3}\).

Taking these numbers we find that the average of the fourteen would be equal to

$$\frac{(1\times5)+(2\times3)+(\frac{2}{3}\times6)}{14}=\frac{5+6+4}{14}=\frac{15}{14}.$$

But the actual average of these fourteen numbers is $22\frac{1}{4}$; i.e., $\frac{14}{15} \times 21$,

therefore each of the assumed averages must be made 21 times greater to obtain the real average;

we thus find that

the average of the first five is $1 \times 21 = 21$, and their sum will therefore be 105.

Also, the average of the next three is 2 × 21 = 42, and their sum will therefore be 126.

The sum of the first eight is therefore 105+126=231,

and their average $=\frac{231}{8} = 28\frac{7}{8}$ Answer.

Example LXXXI.

Divide the number 185 into two parts, such that 10 times the first part added to 12 times the second part shall be equal to one-and-a-half times 1398.

Here $1398\frac{1}{3} \times 1\frac{1}{4} = 2098$.

1st Method.

The second part=185 - the first part.

Now, 10 times the first part + 12 times the second part = 2098,

i.e., 10 times the first part + 12 times (185 - the first part) = 2098, i.e., 10 times the first part + 12 times 185 - 12 times the first part = 2098,

i.e., 12 times 185 - 2 times the first part = 2098, i.e., 2220 - 2098 = 2 times the first part, i.e., 122 = 2 times the first part,

... 61=the first part, and ... 185-61=124=the second part \ Answer.

2nd Method.

 $2098 \div 185 = 11_{18.8}^{63}$

... 10 times the first part + 12 times the second part= 11_{100}^{63} times the two parts.

Subtracting ten times each part, from each side, we get 2 times the second part = 1 1 times the two parts, = 1 1 times 185,

=248, .: the second part=124 | Answer. .: the first part=185-124= 61 | Answer.

Example LXXXII.

Divide 284 into 3 parts, such that 7 times the first, 5 times the second, and 3 times the third shall be all equal.

- (i.) If 7 times the first number be equal to five times the second,

 the first number: the second number:: 1:1
 = 5:7
- (ii.) And if 7 times the first number be equal to three times the third, the first number : the third number :: \(\frac{1}{2}\): \(\frac{1}{2}\)
 = 3: 7
- (iii.) But, in (i.) above, we find the first number is represented by 5; if, then, in (ii.) we substitute 5 for 3, we must substitute (§ of 7, i.e.) 112 for the 7. We now have the ratio, 5:7:112, to represent the proportions of the numbers into which the 284 must be divided to find the answer.
 - By Example XLII. we find that the Answer=60, 84, and 140.

Example LXXXIII.

Divide £1435, 10s. between four persons in such a way that if the first puts out his money for 2 months at $3\frac{1}{2}$ per cent. per annum, and the second invests his share for 5 months at 2 per cent., the third for 7 months at $1\frac{1}{2}$ per cent., and the fourth for 6 months at 4 per cent., their respective amounts of simple interest shall be all equal.

In order that the amounts of simple interest at a number of different rates per cent. may be equal, it is necessary that the sums of money invested at these rates shall be inversely proportioned to the rates per cent at which they are respectively invested;

The given sum must therefore be divided into four portions, which shall stand to each other in the proportions,

By the method of Example XLII. we now find Answer = £540, £378, £380, £157½.

Example LXXXIV.

A man and his wife together can reap a field in 9 days. The man can do as much work in 2\frac{3}{4} days as his wife can do in 4 days. How long would it take each of them to reap the field separately?

The working powers of the man and the woman will be to each other in the inverse ratio of the days they require to perform a given work:

- ... the man's working power: the woman's working power::4:22
- ... the man's working power × 22 = the woman's working power × 4
 - ... the man's working power = $\frac{\text{the woman's working power} \times 4}{2^{\frac{3}{4}}}$

Now, the man and the woman together can reap the field in 9 days;
... 9 times the man's daily work+9 times the woman's daily work
is sufficient to reap the field;

if we now express the man's daily work in terms of the woman's daily work, we find that

9 times $\frac{the\ woman's\ daily\ work \times 4}{2\frac{\pi}{4}} + 9$ times the woman's daily work, is sufficient to reap the field;

i.e., the woman requires
$$\left[\frac{9 \text{ times } 4}{2\frac{5}{4}} + 9 = \right] \frac{22\frac{1}{11}}{15\frac{2}{15}} \frac{\text{days to reap}}{\text{the field}}$$
 and ... the man requires $\left[\frac{2\frac{3}{4}}{4} \text{ of } 22\frac{1}{11} = \right] \frac{15\frac{2}{15}}{15} \frac{\text{days to reap}}{15\frac{2}{15}}$

Example LXXXV.

In a certain parish it is found in the last census that the number of men has decreased 5.4 per cent. since the previous census; the number of women has, however, increased 12.8 per cent., and there is a total increase of 5.2 per cent. What were the percentages of men and of women at the previous census?

For every 100 men there is now only (100-5.4, i.e.,) 946 For every 100 women there is now only (100+12.8, i.e.,) 112.8.

Let M signify the number of men at the previous census, and let W signify the number of women at the previous census,

then
$$\frac{94.6}{100}$$
 M + $\frac{112.8}{100}$ W = $\frac{105.2}{100}$ (M + W);

or, cancelling the 100, which is the same as multiplying by 100 all across, 94.6 M + 112.8 W = 105.2 (M+W);

or, cancelling the decimal point, which is the same thing as multiplying by 10 all across,

946 M+1128 W=1052 M+1052 W; hence 1128 W-1052 W=1052 M-946 M, i.e., 76 W= 106 M,

i.e., 76 times the number of women = 106 times the number of men. Now, 76 + 106 = 182;

... the percentage of men $=\frac{76}{157}$ of $100=41\frac{69}{15}$ and the percentage of women $=\frac{109}{157}$ of $100=58\frac{13}{15}$ Answer.

Example LXXXVI.

A quantity of wine is sold to A at a certain loss per cent. Then A sells it to B, losing at the same rate; but B sells it to C for the original cost and gains thereby 44 per cent. on his outlay. What was the loss per cent. at which A bought and sold the wine?

1st Method.

Suppose the loss to be 15 per cent.;

then A purchases the article for $\frac{85}{100}$ of the original cost;

and ... B purchases the article for $\frac{85}{100}$ of $\frac{85}{100}$ of the original cost; but, by the question, we find that

 $\frac{144}{100}$ of the price B gives ought to be equal to the original cost;

Now, is $\frac{144}{100}$ of $\frac{85}{100}$ of $\frac{85}{100}$ of the original cost = the original cost? in other words, is it true that

the value of
$$\frac{144}{100}$$
 of $\frac{85}{100}$ of $\frac{85}{100} = 1$?

i.e., is $144 \times 85 \times 85 = 100 \times 100 \times 100 = 1000000$?

Answer, NO.

But it is clear that when the answer has been subtracted from 100, a number (corresponding to the 85 above) will be found which when multiplied by itself and then by 144 will give 1000000;

WHAT IS THAT NUMBER?

To find it we must evidently

(1) divide 1000000 by 144; we thus get 1000000

(2) find the square root of this quotient; the number is thus found to be equal to the square root of $\left\lceil \frac{1000000}{12} = \right\rceil$ 831

Therefore.

the Answer = 100 - 831 = 161.

2d Method.

Let A represent the Answer, and C the Original cost; then

B's outlay
$$\times$$
 $\frac{144}{100} = C$ hence, B's outlay = $C \times \frac{100}{144}$. . . (i.

again,

A's outlay =
$$\frac{100 - A}{100}$$
 of C
... B's outlay = $\frac{100 - A}{100}$ of $\left(\frac{100 - A}{100}\right)$ of C. (ii.)

Combining (i.) and (ii.) we thus get
$$C \times \frac{100}{144} = \frac{100 - A}{100} \text{ of } \frac{100 - A}{100} \text{ of } C$$
Dividing each side of the equation by C, we now get
$$\frac{100}{144} = \frac{100 - A}{100} \times \frac{100 - A}{100}$$

$$\cdot \cdot \cdot 100 \times 100 \times 100 = 144 \times (100 - A) \times (100 - A). \text{ [See Ex. XIII.]}}$$
i.e. $1000000 = 144 \times (10000 - 200 A + A^2)$
dividing each side of the equation by 4, we get
$$250000 = 36 (10000 - 200 A + A^2)$$
i.e. $250000 = 360000 - 7200 A + 36 A^2$

$$\cdot \cdot \cdot 36 A^2 - 7200 A = 250000 - 360000 = -110000$$

$$\cdot \cdot \cdot A^2 - 200 A = -\frac{110000}{36}$$
hence $A^2 - 200 A + 10000 = 10000 - \frac{110000}{36}$

$$\cdot \cdot \cdot A - 100 = \sqrt{\frac{250000}{36}}$$

$$= \frac{+500}{-6}$$

$$\cdot \cdot \cdot A = 100 - \frac{+500}{6}$$

$$= 100 - \frac{+83}{4}$$

$$= 183\frac{1}{4} \text{ or } 16\frac{2}{3} \text{ per cent.}$$

N.B.—The other quantity, vis. 183 $\frac{1}{3}$, is mathematically correct also, but if, by the terms of the question, a man should lose 183 $\frac{1}{3}$ per cent, it is clear that he must not only sell it for nothing, but also give the purchaser a bonus to take it for nothing.

Example LXXXVII.

A crew rowing with the stream gets from A to B in 50 minutes; coming against the stream they row from B to A in 65 minutes; compare the rates of the stream and the boat.

The difference in the time = 65 mins. - 50 mins. = 15 mins. In one case the stream *helps* the boat; in the other case it *retards* it by an equal amount;

$$\frac{\text{the speed of the stream}}{\text{the speed of the boat}} = \frac{\frac{1}{3} \text{ of } 15}{50 + \frac{1}{2} \text{ of } 15} = \frac{7\frac{1}{3}}{57\frac{1}{4}} = \frac{3}{23}$$

$$\therefore \text{ Answer} = 3:23.$$

Exercise 62.

 The number of persons in a parish is found to be 43½ per cent. greater than it was ten years ago. The present population is 30135; what was it at the former date?

2. In 1881 the population of a city was found to be 94248, being a decrease of 1 per cent. during the last 5 years. In the five years previous to that period the population had increased 36 per cent.; what was it therefore at the commencement of the decade?

3. The population of A has increased 25 per cent. and is now equal to that of B, which has decreased 25 per cent.; express by a fraction the ratio of the population of A to that of B before their increase and decrease respectively.

4. In the year 1877 it was found that a certain district contained 203685 persons, of whom 86 out of every 185 were women, and that the total population had increased 85 per cent. during 30 years. If the proportion of men to women had remained constant during that period, how many men were there out of every 1101 persons at its commencement?

5. If the number of men in a parish increase 50 per cent. and the women 40 per cent., and the total increase be 42 per cent.; how many women are there finally in every 1000 persons?

6. The speed of a boat rowed with the stream is 7 miles an hour; rowed against the stream it travels 7 miles in 1 hour 20 minutes. Compare the rates of the stream and the boat.

7. A man starts to walk at the rate of 16 miles in 4 hours 15 minutes. After 3 hours, a horseman starts in pursuit and overtakes him in 2 hours 20 minutes. Compare the rates at which the man and the horseman respectively travel.

8. A horseman starts at 12 o'clock in pursuit of a fugitive who escaped at 7 o'clock, and who has fled at the rate of 11 miles in 2 hours 10 minutes; at 11 o'clock they both return, the man having walked the whole way at the same average rate. Compare the rate of the horseman in going with the average speed of the man.

9. A bicycle is sold to A at a gain of 20 per cent, is afterwards

sold to B at a loss. By B it is sold to C at an equal loss. C sells it to the original vendor for half the price at which it was first sold, and thereby loses twice as much per cent. as A. What was the loss per cent. at which B sold it?

10. A sells a horse to B at a gain of 30 per cent., B sells it to C at an equal gain; at what loss per cent. must C sell it to A again in order that A may give for it 90 per cent. of the price at which he originally sold it to B.

11.* Simplify
$$\frac{\left\{\left(\frac{1}{10} - \frac{1}{11}\right) \cdot 1\frac{1}{7} - \left(\frac{1}{91} - \frac{1}{119}\right) \cdot \left(1\frac{1}{3} + \frac{1}{4}\right)\right\}}{\left(\frac{11}{13} - \frac{1}{8}\right) \cdot \frac{1}{7} - \frac{28}{364}}$$
12.* Express
$$\sqrt{\frac{9.864 \times 0.01234}{0.005078 \times 0.00008765}}$$

as an ordinary decimal fraction, correct to three significant figures.

 $0.428571 \times 0.7714285$ 13.* Express $\frac{0.285714 \times 0.0571428}{0.285714 \times 0.0571428}$ as a vulgar fraction, reducing it to its simplest form.

14.* If a farmer lays two tons of lime on an acre of land; how many grammes is that per square metre? Express the result correct to the nearest integer.

[Assume 1 met. = 39\frac{2}{4} in.; 1 kilog. = $2\frac{1}{4}$ lbs.; 1

ton = 2240 lbs.

15.* Divide £100 between 3 men, 5 women, 4 boys, and 3 girls, so that each man has as much as a woman and a girl, each woman as much as a boy and a girl, and each boy half as much as a man and a girl.

16.† A man buys a farm of 150 acres for £4624, and after repairing the buildings, &c., lets it at 30s. per acre, thereby getting a return of $4\frac{1}{2}$ per cent. for his money.

What sum did he spend in repairs?

17.† A dealer lost a sum equivalent to 9½ per cent. on the sale of goods which cost him £3, 9s. 2d., but gained a sum equal to $9\frac{1}{8}$ per cent. on a lot which cost him £7, 10s. How much had he gained or lost at the end of both transactions?

Matriculation Examination, London University, January 1882. † Government Examination of Female Training Colleges, 1881.

Example LXXXVIII.

[Examples lxxxviii. to xciii. are taken from the Government Examination of Training Colleges—Female Students, Christmas 1881.]

In what time will £989, 10s. amount to £1189, 17s. 5.7d. at $4\frac{1}{3}$ per cent. per annum, simple interest?

(ii.) Now £989, 10s, at $4\frac{1}{2}$ per cent. for ONE YEAR produces £ $4\frac{1}{4} \times 989\frac{1}{2}$

But.

the S. I. in 1 year: the total amount of interest:: 1 year: Answer.

i.e.
$$\frac{£4\frac{1}{4} \times 989\frac{1}{4}}{100}$$
: £200, 7s. 5.7d. :: 1 year: Answer.

... Answer =
$$\frac{£4\frac{1}{2} \times 989\frac{1}{2}}{100}$$
 years = $4\frac{1}{2}$ years.

Example LXXXIX.

At a concert, $\frac{1}{16}$ of the audience paid 10s. each for their seats, $\frac{1}{8}$ paid 5s., $\frac{1}{19}$ paid 2s. 6d., $\frac{2}{8}$ paid 1s., $\frac{1}{4}$ paid 6d., and the remaining 38 were let in free. How many attended the concert, and what amount of money was taken?

Since
$$\frac{1}{12} + \frac{1}{12} + \frac{2}{12} + \frac{2}{12} + \frac{2}{12} = \frac{221}{22}$$

it follows that

the number admitted free = $\begin{bmatrix} 1 - \frac{2}{3} \frac{1}{10} \end{bmatrix} = \begin{bmatrix} \frac{1}{3} \frac{1}{10} \end{bmatrix}$ of the whole;

... $\frac{10}{100}$ of the whole number admitted = 38 ... the number admitted = 38 × $\frac{240}{10}$ = 480,

of which

 \therefore Answer = £47 12 0

Example XO.

I sell tea at two prices, one being 50 per cent. higher than the other. A customer ordering 1 cut. of each kind, I sell him the two cut. for £38, 5s. 4d., cheapening the better tea 20 per cent., and the inferior tea 15 per cent. What are the ordinary prices of my two teas respectively?

The ordinary price of 1 cwt. of the better teas
The ordinary price of 1 cwt. of the inferior teas
The sum received for 1 cwt. of the better teas
The sum received for 1 cwt. of the inferior teas
$$= \frac{80 \text{ p. c. of } 150}{85 \text{ p. c. of } 100}$$

$$= \frac{80 \text{ p. c. of } 150}{100}$$

$$= \frac{80 \text{ of } 150}{100}$$

$$= \frac{120}{85}$$

$$= \frac{24}{17}$$

Therefore, of the total receipts for the 2 cwt., $\frac{24}{41}$ are for the better kind, and $\frac{17}{41}$ are for the inferior kind

Therefore, 1 cwt. of the better kind is sold for $\frac{1}{4}$ of £38, 5s. 4d. = £22, 8s. and 1 cwt. of the inferior kind is sold for $\frac{1}{4}$ of £38, 5s. 4d. = £15, 17s. 4d.

Therefore, the ordinary price of 1 cost. of the better kind = $\frac{100}{80}$ of £22, 8s. = £28

and, the ordinary price of 1 cwt. of the inferior kind = $\frac{100}{85}$ of £15, 17s. 4d. = £18, 18s. 4d.

Answer, £28 and £18, 18s. 4d.

Example XOI.

What would be the gross rental of an estate for which the owner received £744, 18s., after a deduction of 6d. in the pound for income tax, and $4\frac{1}{2}$ per cent. on the remainder for collecting, had been made?

(i.) Every £100 of rental is reduced by 100 sixpences for income tax; thus

£100 - £2,
$$10s. = £97$$
, $10s.$

(ii.) The remainder is then reduced by $\frac{4\frac{1}{4}}{100}$ of itself, for collecting; ... out of every £100 rental the owner received

95½ of £97, 10s., i.e. £93, 2s. 3d.

(iii.) £93, 2s. 3d. ; £100 ; £744, 18s. : Answer. Answer = £800.

Example XCII.

I lent a friend a certain sum 20 years ago. He has just paid me £866, 5s., that being the principal and simple interest on my loan to him at the rate of 3 per cent. for ten years, and 3½ per cent. for the remaining ten years. What was the amount lent?

On £100 he received for interest [£3 \times 10 =] £30 in the 1st ten years, and [£3½ \times 10 =] £35 in the 2d ten years,

- ... For £100 lent he now receives £165
- .. £165 : £100 :: £866\frac{1}{2} : Answer.

$$Answer = \frac{£866\frac{1}{4} \times 100}{£165} = £525.$$

Example XCIII.

The owner of $\frac{4}{17}$ of a ship sold $\frac{3}{11}$ of $\frac{2}{5}$ of his share for £12 $\frac{4}{35}$. What would a share equivalent to $\frac{2\frac{1}{5}}{4\frac{1}{5}}$ of the ship cost at the same rate?

The value of
$$\frac{3}{11}$$
 of $\frac{3}{5}$ of $\frac{4}{17} = £12\frac{4}{53}$

... The value of the whole ship =
$$\frac{\pounds 12\frac{4}{55}}{\frac{7}{17} \text{ of } \frac{2}{5} \text{ of } \frac{4}{17}}$$

... The value of
$$\frac{2\frac{1}{3}}{4\frac{1}{4}}$$
 of $\frac{2}{5}$ of the ship $=\frac{\pounds 12\frac{4}{5}}{\frac{1}{11}}$ of $\frac{3}{5}$ of $\frac{4}{17}$ of $\frac{3}{5}$ of the ship $=\frac{2}{3}$ of $\frac{4}{17}$ of $\frac{3}{5}$ of the ship $=\frac{2}{3}$ of $\frac{4}{17}$ of $\frac{3}{5}$ of $\frac{4}{17}$ of $\frac{3}{5}$ of $\frac{4}{17}$ of $\frac{3}{5}$ of the ship $=\frac{2}{3}$ of $\frac{3}{17}$ of $\frac{3}{5}$ of $\frac{4}{17}$ of $\frac{3}{5}$ of

Exercise 63.

1.* What will be the cost of laying turf on a lawn, 30 yards 2 ft. 6 in. long, and 10 yards 1 ft. wide, at 2s. 3d. per sq. yard—two flower-beds, each of which is 10 ft. long and 8 ft. wide, not to be turfed?

2.* Multiply 395.68 by 4.804;—from the product subtract

1525.95, and divide the remainder by 156.337.

- 3.* The diameter of the forewheel of a bicycle is 4²/₇ that of the hind wheel, and the former makes 352 revolutions in travelling a mile. How many revolutions does the hind wheel make in a mile? and what is the circumference of each wheel?
- 4.* A schoolmistress receives £50 a year guaranteed salary, and \(\frac{1}{3}\) of a Government Grant, averaging £59, 10s. Her salary is subsequently increased by $7\frac{1}{2}$ per cent., and the Government Grant rises $11\frac{1}{4}$ per cent. What is then her income?

5.* Find the average of the six following numbers, $\frac{19}{180}$, $8\frac{1}{3}$, $15\frac{7}{6}$, 08, 001, 083.

6.* Two persons buy respectively with the same sum of money into the 3 per cents., and into the 3½ per cents., and get the same amount of interest. The 3 per cents. stand at 75; what do the 3½ per cents. stand at?

7.* If the 3 per cents, are at 923, and the 4 per cents, at 1231, what must be the amount vested in each, in order that the difference of income arising from the two invest-

ments may be one shilling?

8.* A invests £457, 10s. at compound interest for 3 years at 4 per cent.; B invests £477, 10s. at simple interest for the same time, at the same rate. How much more will one receive than the other?

9. In what time will £3005, 10s. amount to £3306, 1s. at 4 per cent. per annum, simple interest?

10. In what time will £8208 amount to £8853, 18s. 7½d. at 3½ per cent. per annum, simple interest?

11. At what rate per cent per annum will £5652 amount to £6446, 16s. 3d. in 2½ years, at simple interest?

^{*} Government Examination of Female Training Colleges, Christmas 1881.

12. At what rate per cent. per annum must £8556 be invested in order that it may amount to £8855, 9s. 2.4d. in 42 years?

13. The number of years for which £6600 is invested is to the rate per cent. per annum as 5: 8, and the total amount of simple interest is £293\(\frac{1}{3}\); what was the rate per cent.?

14. What is the rate per cent., and what is the number of years, when the former is to the latter as 11: 16, and the interest on a sum of money invested at that rate and for one-half that time is 055 of the principal?

15. In a certain firm \(\frac{1}{10}\) of the apprentices receive 8s. a week, \(\frac{3}{8}\) receive 6s. per week, \(\frac{1}{4}\) receive 5s., one-third of the remainder receive 2s. 6d. per week, and the rest nothing. The total wages for 3 weeks amount to £100, 5s. 6d.;

how many apprentices are there in all?

16. Another year, ²/₅ of the apprentices were receiving 8s. per week, ¹/₁₂ were receiving 6s., ⁷/₅₀ were receiving 5s., and of the remainder there were three receiving 2s. 6d. to every seven receiving nothing. The firm received that year £2600 for premiums with apprentices, and found that their expenditure on wages to apprentices was on an average 3s. 6d. per week greater than their income by premiums. How many apprentices had they in all that year?

17. At what prices per ton must two kinds of coal be marked in order that the vendor may receive £1, 19s. 4d. for a ton of each, after allowing 10 per cent. discount on the former and 8½ on the latter, the marked price of the former being 116½ per cent. of that of the latter?

18. A merchant sells timber at three prices, which are to each other as 8, 5, and 20; for ready money he allows a discount of 6¼ per cent. on the first kind, 5 per cent. on the second kind, and 3¾ per cent. on the third kind, and then receives 30 guineas for 5 tons of each kind; what are his prices before reduction?

 The cost of procuring tea in China, bringing it to England, and paying import duties, is 2s. per lb., and is paid by the wholesale merchant, who sells it to the retailer at a profit of $8\frac{1}{3}$ per cent. The retailer always fixes his price at an exact number of threepences, taking care that his gain shall not be less than £14 out of every £45 he receives. What percentage of this selling price represents the cost to the wholesale dealer?

20. An estate is broken up into 42 sections, and each of these sections into 37 plots; 15 of these plots are sold for a thousand guineas. At the same rate, what would have been a fair price for 17 plots if the estate had been broken up into 35 sections only, and each section into 12 plots?

21. Two estates, of equal area, are broken up; one into 30 sections, and each section into 50 plots; the other into 25 sections. If the price of 1 plot of the latter be to that of a plot of the former as 3:2, into how many plots is each section of the latter divided?

22. A sum of money is lent for 4 years at 4 per cent. per annum, simple interest. The amount is then re-invested for 6 years, at 3\frac{3}{2} per cent. simple interest, and at the end of that time amounts to £4049, 17s. What was the sum originally invested?

23. Wine is bought at 60s. and at 75s. a dozen; in what proportion must the two kinds be sold so that the gain at 20 per cent. on the former shall equal that at 30 per cent. on the latter?

24. A candidate at an examination gained 4500 marks; his marks for geography were to those for history as 31:47; the marks for grammar were double those for history; the marks for arithmetic were equal to those for geography and history together; and the marks for science were equal to the sum of those for geography, history, grammar, and arithmetic; what were his marks for each subject?

Example XOIV.

A man who was walking $4\frac{1}{4}$ miles per hour found he would be 10 minutes too late to catch his train, so he quickened his pace

to $4\frac{1}{3}$ miles an hour, and thus reached the station 12 minutes before the train was due. How far was he from the station when he changed his pace?

> By quickening his pace he gains 1 mile per hour; he also reaches his destination 22 minutes sooner; in this 22 minutes he would, at the quick pace, travel

> > $[\frac{2}{6}]$ of $\frac{1}{2}$ miles = $\frac{1}{6}$ mile;

Now $\frac{33}{30}$ mile : $\frac{1}{4}$ mile :: $\frac{1}{30}$ mile is gained :: the time in which $\frac{1}{4}$ mile is gained

... the time in which $\frac{33}{10}$ mile is gained $=\frac{35}{1}$ hours =63 hours.

Therefore, at the slower rate, he would reach the station in 6% hours:

... the distance is 41 miles \times 61 = 28 $\frac{1}{4}$ miles. Answer.

N.B.—Whenever he can conveniently do so, the student should test the answer; in the present sum this can easily be done, thus:-

It is clear that at the quicker rate he reaches the station 22 minutes before he would at the slower pace;

.. he would, at the quicker pace, reach the station in 61 hours-22 minutes, i.e., in 6 hours 14 minutes.

But in 6 hours 14 minutes he travels, at the quicker rate, 41 miles $\times 6_{30}^{7}$, i.e., 28_{30}^{1} miles, and this result corresponds with the one found above.

Example XOV.

A bag contains 234 coins, of which some are crowns, some are half-crowns, some are shillings, and the rest sixpences, the value of each kind being the same. How many are there of each?

Since the values of each kind are the same, for I crown there must

be 2 half-crowns, 5 shillings, 10 sixpences;

Out of every 18 coins there must accordingly be 1 crown, 2 halfcrowns, 5 shillings, 10 sixpences; the problem, therefore, is to divide 234 into four numbers which shall be to each other as 1:2:5:10.

By the method of Example XLII. the answer is found to be-

18 crowns,

26 half-crowns.

65 shillings.

130 sixpences.

Example XOVI.

A saves £50 one year, and £2 less in each successive year afterwards. At the end of 5 years he has saved as much as B, who commenced at the same time, and has been increasing his annual saving by £2 each year. How much did B save the first year?

Let x = B's saving in the first year;

then we have

A's Savings.	B's Savings
The first year, £50	
The second year, £50 - £2 = £48	x+£2
The third year, £48 - £2 = £46	x+£4
The fourth year, £46 - £2 = £44	x+£6
The fifth year, $£44 - £2 = £42$	x+£8

Total = £230 = 5x + £20. $\therefore 5x = £230 - 20 = £210.$ $\therefore x = £42$. Answer.

Example XOVII.

A contractor who has agreed to complete a piece of work in 80 days, finds at the end of 50 days that the work is only half To fulfil his contract he has to put on 20 additional men. How many had he been employing before?

1st Method.

One-half the work is done in 50 days; the other half is done in 30 days;

. . as much work is done in the last 30 days as in the first 50 days; but, when other things remain equal, the number of men required to complete a piece of work will vary inversely with the time they are engaged upon it,

Therefore.

Prefere,

Number of men required to do the work in 50 days $= \frac{30}{50} = \frac{3}{5}$ Number of men required to do it in 30 days

i.e.
$$\frac{\text{Answer}}{\text{Answer} + 20} = \frac{3}{5}$$

Therefore, as in Example XIII., 4th Method, we get 5 times the Answer=3 times (Answer+20) =3 times Answer+60

... 2 times the Answer=60

. . Answer = 80.

2d Method.

Let N=the number of men employed at first; then N+20=the total number employed afterwards by the question we find that

N worked 50 days,

also.

... N × 50 represents the work they did;

N+20 worked 30 days,
... 30 (N+20) represents the work they did;

Therefore,

 $N \times 50 = 30 (N + 20)$ i.e. $N \times 50 = (N \times 30) + 600$.: $N \times 20 = 600$

.. $N = \frac{600}{20} = 80$. Answer.

Example XOVIII.

(Civil Service Examination Paper).

It was found at a siege that a certain length of trench could be dug by the soldiers and navvies in 4 days, but that when only half the navvies were present, it required 7 days to dig the same length of trench. What proportion of the work was done by the soldiers?

1st Method.

The soldiers and all the navvies can do the work in 4 days; but when the soldiers are helped by only half the navvies it requires 3 days more to do the work;

... the work which half the navvies would have done (if they had been employed) in 4 days is done by the other half of the navvies, assisted by the soldiers, in 3 days;

the help of the soldiers thus enables half the navvies to do in 3 days what, without their help, would have occupied the navvies 4 days;

... the soldiers' work for 3 days=the work of half the navvies for 1 day:

1 day;
... the work of the soldiers for 6 days=the work of all the navvies for 1 day;

.. out of 7 units of work done by the soldiers and all the navvies working together, the soldiers did 1;

in other words, the proportion of work done by the soldiers

 $=\frac{1}{\pi}$ Answer.

2d Method.

Let S=total work done by the soldiers in 1 day, and N=total work done by all the navvies in 1 day;

Then

$$4(S+N)=7\left(S+\frac{N}{2}\right)$$

i.e.
$$48+4N=78+\frac{7N}{2}$$

multiplying each side of the equation by 2, we get

$$8S+8N=14S+7N$$

i.e.
$$N = 6 S$$

i.e. the navvies do each day 6 times as much as the soldiers;

.. as in 1st Method, Answer = $\frac{1}{7}$

EXERCISE 64.

- 1. A royal messenger, travelling on horseback, is expected to reach a certain place in 19 hours; 8 hours after he has departed another is sent after him with later instructions, and succeeds in overtaking him when he is yet an hour's ride from his destination. What is the relative speed of each?
- 2. In Question 1, the second messenger returns at the speed with which the first one had set out; the first messenger, however, having received his new instructions, quickens his rate of travelling, delivers his message, returns immediately, and thus arrives home as soon as the other. Show by a simple fraction the relation in which his first rate stands to his second.
- 3. Two horsemen have an equal distance to travel; the speed of the first one is to that of the second one as 5:6½, and the time of the second one is to that of the first one as 6½:7. The first one performed the journey without stopping, but the second one rested on the way. Express by a simple fraction the ratio of the time the one spent in resting to that which the other spent in travelling.

4. The wages of an engine-driver vary as the product of the miles run into the hours he has taken to run them. On Tuesday he ran 113 miles in 10 hours, and received 7s.; what ought he to receive on Wednesday when he ran double the distance in 13 of the time taken on Tuesday?

5. On another line the wages vary directly with the miles run, and indirectly with the time occupied, and a man's wages on Friday for running 280 miles in 11½ hours were 9s. 6d.; how many hours was he on Saturday in

running 300 miles if his wages were 10s.?

6. The charge for conveying a case of goods 100 miles is 15s, on one line, and 16s. 3d. on another. By the former line empties are charged 5d. per lb.; by the latter they are returned free. The total charge for sending the case by one line is 1½ times that of the other. What is the weight of the case?

 A parcel of 1395 coins contains an equal value of sovereigns, half-sovereigns, florins, and threepenny pieces; what is

the number of florins?

8. In a sugar manufactory the men receive 7s. a day, the women 4s., the boys 1s., and the girls 9d., and a week's wages amount to £459. If the total wages of the men, the women, the boys, and the girls, be all equal, how many

of each are engaged at the factory?

9. If, in Question 8, each man's wages be reduced 3d. per day, and each woman's by a like amount, while each boy's wages are increased 25 per cent., and each girl's 11½ per cent. while the total wages of the men are 50 per cent of that of the women, the total wages of the boys 75 per cent of those of the girls, and the girls receive in all 250 per cent of the money received by the men, and the total wages of all the people employed be £4181 625 per week, how many men, women, boys, and girls respectively are employed?

10. Two pipes will empty a cistern in 20 minutes; one of them alone would empty it in 32 minutes; in how long would

the other do so?

11. The cost of a certain number of ducks added to that of

some fowls will amount to £10, but the same number of ducks and half the former number of fowls are worth

only £7; what is the value of the ducks?

12. If the price of a number of rabbits be added to that of a number of hares, the total is £15, 15s., but if only one-third of the hares be bought, the price is £12, 12s. What fraction of the £15, 15s. represents the price of the rabbits?

13. The wages of a certain number of engine-drivers added to the wages of a certain number of firemen will amount to £55, 10s. If the wages of the drivers be raised 25 per cent., and the wages of the firemen be reduced from a certain number of guineas to an equal number of pounds, the total wages of the two classes of men will be £60. Find the relation of the original wages of a

driver to those of a fireman.

14. It is found that a piece of work can be done by 18 men in 12 days with the help of 15 boys working 5 days; also, by 12 men working 10 days with the help of 20 boys working 8 days. Find (1) the relation of a boy's daily work to a man's daily work; (2) how long it would take 20 men to do it alone; (3) how long it would take 10 men and 10 boys; (4) for how long 6 men and 10 boys must respectively work in order that each body may complete one-half the work; (5) for how long 20 men and 8 boys must work on the job in order to complete it in such a way that a man's total wages and a boy's may be equal to each other.

15. It is required to empty a reservoir in 48 hours, and pumps are set to work. At the end of 35 hours there is three-eighths of the water still remaining; two more pumps are then set to work, and the reservoir is thus emptied 24 minutes before the expiration of the 48 hours. How

many pumps were originally at work?

16. After a number of men have been engaged for 15 days in building a wall, their employer finds that he must keep them at work for 9 days longer to finish it; as he has made a contract to complete the wall in 21 days, he puts on 18 more men, and then gets it finished in time.

- with 3\frac{3}{2} days to spare. How many men were employed at first?
- 17. The present age of A is to the present age of B as 23/2 : 63/3 : in 21 years time the age of A will be to that of B as 4:5. What are their respective ages now?
- 18. When £15 has been added to my money, and the same sum has been added to my brother's money, I shall have \(\frac{13}{18} \) as much as he; if his money be then increased by another £15, while mine is reduced by a like amount, he will have 3\(\frac{3}{1} \) times as much as I; how much had we each at starting?
- 19. The pay of one man per hour is to that of another as 11.7: 14.3, and the hours worked by the former are to those worked by the latter as 10.5: 14.7. Divide £5 between them in the ratio of their respective earnings.
- 20. In the English system a circle is divided into 360 degrees, each degree into 60 minutes, and each minute into 60 seconds. In the French system each circle is divided into 4 quadrants, each quadrant into 100 grades, each grade into 100 minutes, each minute into 100 seconds. Find (1) how many grades are equal to an angle of 60 degrees; (2) how many degrees are equal to an angle of 90 grades; (3) the relation of a degree to a grade; (4) and of a French second to an English second; (5) how many grades there are in the angle of a Pentagon; (6) if one angle of a plane rectilineal triangle be 25 degrees, how many grades there are in the sum of the remaining angles; (7) if the vertical angle of an isosceles triangle be 20 grades 15 minutes, the number of English seconds there are in each of the angles at the base.
- 21. A metre is the 10.000,000 th part of a quadrant of the earth's circumference, and is estimated as 39.3708 English inches. Find the length of the equatorial circle, and express it in English miles; find also the value of a grade of that circle expressed in English inches.

MENSURATION OF SURFACES AND SOLIDS.

The Student should thoroughly master the following USEFUL MEMORANDA:—

Mensuration of Surfaces.

- 1. The area of any PARALLELOGRAM =
 the length of one of its sides × the perpendicular distance
 between it and the opposite side.
- 2. A RECTANGLE is a parallelogram having one of its pairs of sides perpendicular to the other pair; therefore the AREA of a Rectangle = the product of two of its adjacent sides.
- 3. A SQUARE is a rectangle having all its sides equal; therefore

the AREA of a Square = the square of one of its sides, or,

one-half the product of its diagonals.

4. The area of a TRIANGLE is one-half that of a parallelogram on the same base and between the same parallels; therefore

the area of a Triangle =
$$\frac{base \times perpendicular \ height}{2}$$

If a, b, c, represent the three sides of a triangle, then the area of the Triangle =

$$\sqrt{\left(\frac{a+b+c}{2}\right) \times \left(\frac{a+b+c}{2}-a\right) \times \left(\frac{a+b+c}{2}-b\right) \times \left(\frac{a+b+c}{2}-c\right)}$$

N.B.—If for $\frac{a+b+c}{2}$ we write s, the above formula may be shortened, thus

the area of the Triangle =
$$\sqrt{s(s-a)(s-b)(s-c)}$$
.

- 5. The area of any Rectilineal figure is equal to that of the triangles into which it may be divided; therefore the area of such a figure may be found by adding together the areas of its component triangles. [See (4) above.]
- 6. A TRAPEZIUM is an irregular figure having four rectilineal sides; and

the AREA of a Trapezium = the sum of the areas of its two triangles; or,

$$=\frac{diagonal \times the sum of the perpendiculars}{2}$$

- 7. A TRAPEZOID is a four-sided rectilineal figure having one pair of its opposite sides parallel; and
- the AREA of a Trapezoid = the sum of the areas of its two triangles; or,
- = one-half the sum of the parallel sides × perpendicular distance between them.
- 8. A RIGHT-ANGLED TRIANGLE is one that contains a right-angle; and
- the square on the line which is opposite the right-angle is equal to the sum of the squares on the lines which contain the rightangle.
- 9. In any circle, the circumference = the diameter × 3·1416 and, the diameter = the radius × 2 and the AREA of the Circle =
 - (1) the square of the radius × 3.1416
 - or, (2) the square of the diameter × 7854
 - or, (3) $\frac{the\ circumference}{2} \times \frac{the\ diameter}{2}$
 - or, (4) $\frac{1}{4}$ of (the circumference × the diameter)
 - or, (5) (\frac{1}{2} \text{ of the circumference})^2}{7854}
- 10. The areas of two, or more, circles are to each other as the squares of their diameters; in other words, if there be four circles A, B, C, D, having diameters, a, b, c, d, respectively,

then the areas of the circles A, B, C, D, will be to each other as $a^2:b^2:c^2:d^2$.

11. A SECTOR of a Circle is the figure contained by two of its

radii and the arc intercepted between them.

In any given circle the area of the sector will vary directly with the size of the arc which helps to contain it; therefore, in any given circle

the area of a sector the area of the circle = $\frac{No. of degrees in the arc of the sector}{360}$

the AREA of a sector = $\frac{radius \times length \ of \ arc}{2}$

- 12. The area between two concentric circles =
- (1) The difference of their separate areas;
- or (2) sum of their diameters × DIFFERENCE of their diameters × 7854.
 - N.B.—In this way the area of a circular ring may be found.
 - 13. The area of an ellipse =

the product of the axes × .7854,

Mensuration of Solids.

1. The VOLUME of a Parallelopiped = the area of one of its sides × the length of the perpendicular between that and the opposite side.

2. A Cube is a parallelopiped which has all its sides squares;

therefore,

the VOLUME of a cube = the cube of one of its edges.

N.B.—The SURFACE of a cube consists of six sides, the surface of each of which is found by squaring one of the edges of the cube; therefore,

the surface of a cube = 6 times the area of one side = 6 times the square of its edge

- 3. The volume of a Cylinder = the area of the base \times the perpendicular height.
- 4. The volume of a Prism = the area of the base × the perpendicular height.

- N.B. 1.—In a prism, the base is considered to be one of "the ends;" i.e. one of the sides which are not necessarily rectangular. The prisms used in optics generally have triangular bases, and their perpendicular heights are measured from one of these triangular faces to the other.
- N.B. 2.—Combining (1) (2) (3) and (4), we find that the volume of a parallelopiped, or a cube, or a cylinder, or a prism, may be found by multiplying its base by its perpendicular height.
- 5. The SURFACE of a parallelopiped, a cylinder, or a prism = twice the area of the base + (the perimeter of the base × the perpendicular height).
 - 6. The volume of a sphere =

cube of diameter
$$\times \frac{3.1416}{6} =$$
 cube of diameter $\times .5236$.

- 7. The volumes of two or more spheres are to each other as the cubes of their diameters; in other words, if there be three spheres, A, B, C, having diameters a, b, c, respectively, then the volumes of the cubes A, B, C, will be to each other as $a^3:b^3:c^3$.
 - 8. The surface of a sphere =

(1) circumference × diameter; or,

(2) the square of the diameter × 3.1416.

- 9. The surfaces of two or more spheres are to each other as the squares of their diameters.
 - 10. The volume of a pyramid =

11. The volume of a CONE =

the area of the base × perpendicular height

3

12. The SURFACE of a pyramid or a cone =

area of base +

perimeter of base × slant height

Example XCIX.

The diagonal of a certain rectangle is 17 feet in length, and one of its sides is 10 feet long. What is the area of the rectangle?

Let a represent the other side of the figure;

then $17^2 = 10^2 + a^2$ i.e. $289 = 100 + a^2$ $289-100=a^2$ i.e. $189 = a^2$ $\therefore a = \sqrt{189}$

.. Answer = $10\sqrt{189} = 187$ ag. ft. nearly.

. Exercise 65.

- 1. What is the surface of the upper and lower sides of a flat ring whose internal diameter is 2 ft. 6 in., and whose width is 5 in.?
- 2. Two sides of a field are parallel, and measure respectively 135 yd. and 91 yd. 2 ft.; the distance between them is 101 vd. Express the area of the field in acres.
- 3. The fronts of a row of 25 houses form the south side of one street, and the backs of them form the north side of the next street, parallel with the first one. The average frontage of each house is 17 ft., and the average width of the back premises is $19\frac{1}{3}$ ft.; the distance from front to rear is in each case 95 yd.; find the acreage of the plot of land upon which these houses stand.

4. The value of a circular copper plate whose diameter is 91 in. is £5; what is the value of another circular plate whose radius is 65 in., and whose thickness is '7 of that of the other?

5. A rectangular plate of copper is 15 in. long and 13 in. wide, and is worth a guinea. What is the value of the largest circular plate which can be cut out of it?

6. If the air which fills a cube, whose side measures 10 feet, be compressed within a globe whose diameter measures 71 ft., what simple fraction will express its density in the first case as compared with that in the second?

7. The amount of water condensed out of the atmosphere annually would cover to the depth of one mile an area

of 200,000 square miles. If this were collected into a liquid globe, what would be its radius?

8. A volume of mercury is 13½ times heavier than the same volume of water. What would be the radius of a sphere of mercury which should be equal in weight to that of the water sphere mentioned in Question 7?

9. Thirteen cubic feet of air weigh 1 lb. avoir.; what will be the weight of air in Westminster Hall, which is 290 ft.

long, 68 ft. wide, and 110 ft. high?

10. The air which a sphere contains when full is found to weigh 100 grains; the pure nitrogen which would fill it weighs 97 grains. Two unequal spheres are now taken; the one is filled with as much air as weighs 500 grains, and the other with as much nitrogen as weighs 450 grains. Express, by a decimal, the ratio of the diameter of the nitrogen sphere to that of the air sphere.

11. Huxley computes the weight of the atmosphere at 26,345,088 tons, and the weight of 13 cubic feet (at the sea-level) at 1 lb. avoir. If the atmosphere were of uniform depth and an even density, which should be to that now existing at the sea-level as 1:4, what would be the depth of the hollow sphere of air which would then surround

the earth?

12. Of 100 volumes of pure air 20.8 are oxygen, and the rest is nitrogen. If the oxygen in a given volume of air be formed into a sphere, and the nitrogen be formed into another sphere, what fraction would express the ratio of the radii of the two spheres?

13. What is the cost of carpeting a room whose opposite sides are parallel, the length of one side being 88.3 ft., and the perpendicular upon it from the opposite side being 101.6 ft., and the cost of the carpet per square yard

being 6s. 3d.?

14. In a certain prison water is pumped by a horse which travels round in a circle whose diameter measures 14½ yards. While the horse makes the journey 15 times a prisoner climbs the treadmill twice. The pumping power of the horse per hour is found to be eleven times that of the treadmill. Express by a vulgar fraction the

relation of the work done by each revolution of the respective mills; find also the diameter of the wheel of the treadmill.

15. There are two prisms of equal volume; the base of one is an equilateral triangle, having a side of 17 inches; that of the other is a regular hexagon, having a side of 12 inches. Compare their respective heights.

16. Two wooden cones of equal volumes displace volumes of water which are to each other as 17:18. If they float with their apices vertically over the centre of their bases, find the ratio of the circles which they make with the top of the water.

17. And if the positions of the cones be then reversed, so that their apices be vertically under the centres of their bases, find the relation of the distances between their bases and the top of the water.

18. If a cone and a cube contain equal volumes, find the value of

(1) base of cone; (2) height of cone side of cube;

the diagonal of the face of the cube being equal to the diameter of the base of the cone.

A cone and a half-sphere stand upon equal bases and contain equal volumes; find the value of

height of cone radius of its base

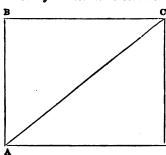
20. The top of a flower-pot measures 7 in., its base 4 in., its height 6 in. It is filled with earth and stands under a glass shade, the main part of which is cylindrical and measures 13 in. across at the bottom, but has its top shaped like a half-sphere; its total height is 27 in. What is the volume of air enclosed beneath the glass shade?

21. A cubic foot of water weighs 1000 ounces, and the relative weights of air and the vapour of water are as 1:0.6235. If the glass shade of Question 20 be filled with a mixture of air and watery vapour on a spring morning, what volume of the vapour must be present if the weight of the contents of the shade be found to be 7/8 of a similar volume of dry air?

Example C.

A room is 21 ft. long and 16 ft. wide; what will be the length of a diagonal line drawn across the room from corner to corner.

Here AB=16 ft. and BC=21 ft. And, by Euc. I. 47, we know that AC=AB^2+BC^2 = 256 sq. ft. +441 sq. ft. = 697 sq. ft. ... AC = $\sqrt{697}$ sq. ft. = 26 4 ft. Answer.



Example OI.

A box is 8 ft. long, 6 ft. wide, and 5 ft. deep. Find the length of its diagonal.

(i.) Find the diagonal of the bottom of the box, as in Example C. thus,

diagonal of bottom = $\sqrt{8^2+6^2}$ sq. ft. = 10 ft.

(ii.) Take this 10 ft. as one of the sides of a new right-angled triangle, the other side being the height of the box, and find the length of the hypotenuse; thus,

Answer = $\sqrt{10^2 + 5^2}$ sq. ft. = $\sqrt{125}$ sq. ft = 11.18 ft.

Example CII.

The dimensions of a cistern are as 3:4:5; it is full of wine, for which the owner will charge 5s. a gallon. He is a mean man, and contrives to sell each gallon short by 106192 of a cubic inch, and so receives for his wine the sum of £15000; what are the dimensions of the cistern?

(i.) An imperial gallon contains 277.274 cub. in.

... the wine merchant's false gallon contains

[277·274 - ·106192 =] 277·167808 cub in.

(ii.) He is paid 5s. for each false gallon;
 he is paid £15000 for (15000 × 4, i.e.) 60000 of these gallons;

... the cistern contained 277.167800 cub. in. $\times 60000$

(iii.) The dimensions of the cistern are as 3:4:5;

let 3a = its height 4a = its width5a = its depth

then $3a \times 4a \times 5a = its$ cubic contents:

i.e. $60a^8$ = its cubic contents:

$$\cdot \cdot \cdot 60a^3 = 277 \cdot 167808$$
 cub. in. × 60000

$$a^3 = \frac{277 \cdot 167808 \text{ cub. in.} \times 60000}{60}$$

 $=277 \cdot 167808$ cub. in. $\times 1000$

=277167.808 cub. in.

 $a = \sqrt[3]{277167.808}$ cub. in.

=65.2 in.

Therefore.

depth of cistern =
$$65 \cdot 2$$
 in. $\times 3 = 195 \cdot 6$ in. width of cistern = $65 \cdot 2$ in. $\times 4 = 260 \cdot 8$ in. length of cistern = $65 \cdot 2$ in. $\times 5 = 326$ in.

Example CIII.

The dimensions of a rectangular box are as $2\frac{1}{2}$: $3\frac{3}{4}$: $6\frac{1}{4}$, and to cover it with lead at 9d. a sq. ft. will cost 11s. 71d. more than to cover it with zinc at $7\frac{1}{2}d$. a sq. ft. What are its dimensions?

(ii.) Let 2a = its height

then 3a=its width; and 5a=its length:

and $\therefore 2(3a+5a) \times 2a = \text{sq. ft. in the surface of its sides,}$ and $3a \times 5a$ = sq. ft. in the surface of its top, and =sq. ft. in the surface of its bottom. $3a \times 5a$

Therefore the sq. ft. in its whole surface =

$$[2(3a+5a) \times 2a] + [3a \times 5a] + [3a \times 5a] = 32a^2 + 15a^2 + 15a^2 = 62a^3$$

(iii.) The difference in the cost per sq. ft is (9d. - 74d., i.e.) 14d.

... The number of sq. ft. in the whole surface =
$$\frac{11s. 7\frac{1}{2}d.}{1\frac{1}{4}d.} = 96$$

But the number of sq. ft. in the whole surface is represented by

```
62a2 (see ii. above)
... 62a^2 = 93 sq. ft.
        a^3 = \frac{23}{63} sq. ft. = \frac{2}{3} sq. ft.
        a = \sqrt{\frac{2}{3}} \operatorname{sq. ft.}
```

Therefore, the height = $2\sqrt{\frac{1}{3}}$ sq. ft. = 2.45 ft. nearly the width = $3\sqrt{\frac{1}{3}}$ sq. ft. = 3.67 ft. the length = $5\sqrt{\frac{1}{3}}$ sq. ft. = 6.12 ft.

Example CIV.

A sound wave is spreading itself through a layer of air at the rate of 1100 ft. per second. At the end of 10 seconds it reaches air of a different elasticity, and its velocity increases 10 per cent. Express by a fraction the ratio of the circular areas through which the wave spread itself during the second and third periods, of five seconds each, of its course.

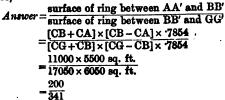
Let C be the centre from which the wave is spreading, and Let A, B, G, be the points, in one direction, which it has reached at the end of 5, 10, and 15 seconds respectively;

Then CA = 5500 ft. AB = 5500 ft. $BG = \frac{1}{10}$ of 5500 ft. = 6050 ft. And,

during the SECOND period, the wave spreads over the surface contained between the circle AA' and the circle BB';

and. during the THIRD period, it spreads over the surface contained between BB' and GG':

therefore,



Example CV.

When the pressure remains constant, the expansion of a gas is 003665 of its volume for each additional degree of temperature. What is that volume of gas which, being raised 3° Centigrade in its temperature, has a volume of 30.6 cubic inches?

$003665 = \frac{1}{4}$

If 1 cub. in. of gas have its temperature raised 3° it will gain [3*5 =] 1 cub. in.;

its new volume will thus be 11 cub. in.,

therefore,

 $1\frac{1}{91}$: 1::30.6 cub. in.: Answer. Answer=80.3 cub. in.

Exercise 66.

- 1. What is the length of the diagonal of a square foot?
- 2. What is the length of the diagonal of a cubic yard?
- 3. The diagonal of a square is 81 inches; what is the length of its side?
- 4. The diagonal of one face of a cube is 15 inches; what is its cubic content?
- A square and a circle have equal diameters; express the area of the former as a decimal of the latter.
- 6. A sphere and a cube have equal diameters; express the perimeter of the greatest circle of the former as a decimal of the perimeter of one face of the latter.
- 7. The dimensions of a box are as 2.2:3.3:12.1, and it contains 22.638 cub. ft.; what is the length of its short side?
- What is the length of the diagonal of a rectangular box whose length is 2½ ft., width 1 ft. 8 in., and height 1 ft. 3 in.;
- The dimensions of a rectangular reservoir are as 3:7:11, and it contains 25000 gallons. Find its depth, expressed to the nearest inch.
- 10. To build a reservoir with brick, which costs 6½d. a sq. ft., will be cheaper by £50 than to build it with stone at 7½d. per sq. ft. The width of the reservoir is to its height as

5:2, and its length is half as much again as its width. Find its dimensions to the nearest tenth of an inch.

11. The intensity of a sound is found to vary inversely as the square of its distance from the sounding body; find a decimal number which shall express the relation of the intensity of a sound which is heard 2½ seconds after its production to that of an exactly similar sound heard 3½ seconds after its production.

12. The illuminating power of a candle varies inversely with the square of its distance from the illuminated body; a sheet of white paper is placed vertically between two candles, and it is found that both sides of the paper are equally illuminated though one candle is 1\frac{1}{3} times as far away from the paper as the other is. Compare their illuminating powers at equal distances.

13. Hydrochloric acid contains equal volumes of hydrogen and chlorine. On a square sheet of paper, whose edge measures 18 inches, make an outer "frame" (or hollow square) to represent the volume of the hydrogen, while the central square enclosed by this frame shall represent the chlorine.

14. Oil of vitriol consists of oxygen, hydrogen, and sulphur combined together in volumes, which are (in the order given above) as 1: ½: ½. Upon a square sheet of paper, whose side measures 15 inches, I wish to mark an outer "frame" (or hollow square) to represent the volume of the oxygen, a middle "frame" to represent the hydrogen, and a central "square" to represent the sulphur. What will be the length of the outer edge of each of these figures?

15. What is that volume of gas which, being made 5° C. hotter, fills a cube whose edge measures 1.3 feet?

16. What is that volume of gas which will fill a sphere, the diameter of which measures a metre, when its temperature has been raised 10° C.?

17. After a body of gas has had its temperature lowered 15° C., it fills 151 cub. in. What was its volume before cooling?

18. If a gaseous body be made to fill 21 cub. in. more by heating it 1° C., what will be its volume after heating?

19. The volume of a gaseous body whose temperature is 16° C. is 100 cub. ft.; what would be its volume at 32° C.

20. The difference between the volume of a gaseous body at 16° C. and at 21° C. is 150 cub. in.; what would be its volume at 10° C.?

21. The length of a bar of metal is to its width as 2·1 : 1·4; its width is to its thickness as 12·1 : 9·9. Express, by a fraction in its lowest terms, the ratio of the thickness

of this bar to its length.

22. A man works for 10 hours and receives a guinea; how much should another man receive who works 21 hours on a job for which the first man would receive 2s. 6d. per hour, but for which he himself receives pay per hour which is to that of the first man on the first job as 11:101;

23. In the year 1865 a man had two sons, one being 17 years old, and the other 14½; in that year he made his will, and provided that when he died his property should be divided between his sons in the inverse ratio of their ages. At last he died, and one son received £2184, and the other £1904. How long did the old man live after making his will?

24. My clock is right at 12 o'clock on Tuesday at noon. The hour hand travels 25 per cent. too quickly, and the minute hand 20 per cent too slowly, at what real time

· will the two hands next be together?

25. Two brothers go into business in the same year; the elder makes 20 per cent, compound interest, for three years; the younger makes 25 per cent, compound interest, during the same period, and at the end thereof finds himself as rich as his brother. What fraction, in its lowest terms, will express the ratio of the younger brother's capital to that of the elder?

26. If I win a wager upon which I have staked a thousand guineas, I shall increase my wealth to \(\frac{10.7}{9.3} \) of what it will be if I lose the bet. If the bet be withdrawn, and the stakes returned, by what number must my total wealth then be multiplied to find the wealth I should

have had if I had lost the bet?

SCALES OF NOTATION.

(1.) If we examine such a number as 8325, written according to the ordinary system of notation, we find that it is made up of

5 units = 1 \times 2 tens = 10 \times 3 hundreds = $10^2 \times$ 8 thousands = $10^3 \times$

In such a system the radix or base is 10, because the value of a figure becomes ten times greater when it is removed one place further to the *left*, and ten times *less* when it is removed one place further to the right.

But it is possible to use numbers other than TEN for the radix of a system of notation—e.g., we might take EIGHT. We should then find that

$$(3726)_8 = 6 \text{ units} + 2 \text{ eights} + 7 \text{ times } 8^2 + 3 \text{ times } 8^3$$

= $(6 \times 1) + (2 \times 8) + (7 \times 8^2) + (3 \times 8^3)$

which may be expressed in the ordinary scale, thus-

$$= 6 + 16 + 448 + 1536$$

= 2006.

(2.) We have here transformed a number expressed by the scale whose radix is *eight* into one whose scale is *ten*. Let us now again transform the number thus found into its original scale. It may be done thus:—

$$2006 = 2006$$
 units.

Dividing 2006 by 8, we find that

 $2006 \ units = 250 \ eights + 6 \ units$.

Dividing 250 by 8, we find that

 $250 \ eights + 6 \ units = 31 \ times 8^2 + 2 \ eights + 6 \ units.$

Dividing 31 by 8, we find that

31 times $8^2 + 2$ eights + 6 units = 3 times $8^3 + 7$ times $8^2 + 2$ eights + 6 units = $(3726)_8$.

The whole operation may be
$$\begin{cases} 8 & | 2006 \\ 8 & | 250 - 6 \\ 8 & | 31 - 2 - 6 \\ \hline 3 - 7 - 2 - 6 \\ Answer = (3726)_8 \end{cases}$$

(3.) The following is a list of the scales having radices less than 13:—

The scale is termed

Binary	when	the	radix	is	2	Octonary	when	the	radix	is	8
Ternary	,,	"	"	,,		Nonary	,,	"	"	"	9
Quaterna	ry "	29	"	,,		Denary	,,,	"	"	"	10
Quinary Senary	99	"	>>	,,	5 6	Undenary Duodenar		"	"	"	11
Septenary))	"	"	"	7	Duouenur	<i>y</i> "	"	"	"	14
Deplemany	"	"	"	"	•						

Example CVI.

Transform 485 from the denary to the septenary scale, and prove the result by converting it into the denary scale.

1st Operation.	Proof.
7 485	1262
7 69 - 2	7
7 9 - 6 - 2	9
1-2-6-2	_7_
	69
Anmoer (1262)	485

N.B.—The method of the proof is exactly the same as that for the conversion of £ s. d. to pence.

Example CVII.

Transform 4251 from the senary to the denary scale.

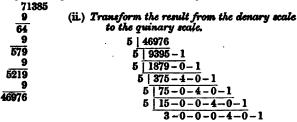
1st Operation.	Proof.			
4251	6 967			
6	6 161 – 1			
26	$6 \mid 26-5-1$			
6	$\frac{1}{4-2-5}-1$			
161				
6				
Ans. 967	$=(4251)_6$			

Example OVIII.

Transform 71385 from the nonary to the quinary scale, and prove the result.

Method.

(i.) Transform the given number into the denary scale:—



Answer = (8000401) 5.

Proof,

To prove the above, the 3000401 in the quinary scale must be expressed in the nonary scale.

This may be done in two ways; thus—

1st Method.

(a) 3000401 (quinary scale)=46976 (denary scale).

15	(b) 46976 (denary scale)=71385 (nonary scale).
5	9 46976
75	9 5219 - 5
5	9 579 - 8 - 5
375	$9 \mid 64 - 3 - 8 - 5$
5	$\frac{101000}{7-1-3-8}$ -5
1879	7-1-0-0-0
5	•
9395	•
5	•
46976	

2d Method.

The 3000401 (quinary scale) may be directly converted into the nonary scale, if at each step of the operation it be carefully remembered that the value of each digit in the 3000401 is five (NOT ten) times what it would be if its place were one further to the right. The work may thus be exhibited:—

Example CIX.

Add together 527, 631, 73, and 405 in the octonary scale; transform the sum into the quaternary scale, and multiply the result by 3.

$$\begin{array}{c} \text{(i.) } 527 \\ 631 \\ 73 \\ \underline{405} \\ \hline{2060} \end{array} \\ \begin{array}{c} \text{(octonary scale)}. \end{array} \\ \begin{array}{c} \text{(ii.) } 4 \mid \underline{2060} \text{ (octonary scale)}. \\ 4 \mid \underline{414} - 0 \\ \underline{4 \mid 103 - 0} - 0 \\ \underline{4 \mid 20 - 3 - 0} - 0 \\ \underline{4 \mid 20 - 3 - 0} - 0 \\ \underline{1 - 0 - 0 - 3 - 0} - 0 \end{array} \\ \end{array}$$

.: (2060)₈=(100300)₄. (iii.) 100300 (quaternary scale).

Ans. = $\overline{802100}$ (quaternary scale).

Example CX.

Multiply 6527 in the octonary scale by 135 in the same scale, and divide the product by 6.

(i.) 6527 (octonary scale). 135 (octonary scale). 41263 24005 6527 1154233 (octonary scale). 147804 4 Ans.

Example CXI.

Divide 20066364 by 423, both numbers being written in the septenary scale.

423) 20066364 (31526 Answer. 1602 1046 423 3235 3051 1526 1146 3504

3504

MISCELLANEOUS EXAMPLES.

Example CXII.

The exchange at Paris upon London is at the rate of 25.70 france for £1 sterling, and at the same place upon Milan it is at the rate of 20 france for 42 Austrian lire. How many Austrian lire should be paid for £50 in English gold?

1st Method. (First Principles.)

25 70 francs = £1

1 franc = £
$$\frac{1}{25.7}$$

20 francs = £ $\frac{1}{25.7}$

But 20 francs = 42 Austrian lire.

$$\therefore £\frac{20}{25.7} = 42 \text{ Austrian lire} \times 25.7$$

$$\therefore £20 = 42 \text{ Austrian lire} \times 25.7$$

$$\therefore £1 = \frac{42 \text{ Austrian lire} \times 25.7}{20}$$

$$\therefore £50 = \frac{42 \text{ Austrian lire} \times 25.7 \times 50}{20}$$

$$= \frac{42 \times 25.7 \times 50}{20 \times 10} \text{ Austrian lire}.$$

$$= 2698.5 \text{ Austrian lire}. Answer.$$

2d Method. (Chain Rule).

£1 = 25.7 francs.
20 francs = 42 lire.

$$x$$
 lire = £50.
 x lire = £50.
 x lires = £50.

... Answer = 2698.5 lire.

Example CXIII.

If I go to Paris with 85 sovereigns, 13 half-sovereigns, and 5 half-crowns, and spend there $\frac{3}{4}$ of the money; how much money (expressed in francs and decimals of a franc) shall I bring back with me after deducting £5 for railway fare? The exchange is 25 francs 15 centimes per £1.

The value of 85 sovs. +13 h. sovs +5 h. crowns = £92 125. Now if I spend \S of my money, I have \S of it remaining.

... I have remaining \(\frac{1}{2} \) of £92.125 = £30.7083.

. ·. I return with (£30.7083 - £5=) £25.7083.

But £1 = 25.15 francs.

 $£25.7083 = 25.15 \text{ francs} \times 25.7083.$

 $= 25.15 \text{ francs} \times [25.7 + 0.083].$

 $= [25.15 \text{ francs} \times 25.7] + [25.15 \text{ francs} \times \frac{1}{110}].$

=646.355 francs + 209583 francs.

=646.564583 francs. Answer.

N.B.—The student should carefully note the method here pursued for finding the value of 25.15 francs × 25.7083. By the application of this method it is sometimes possible to greatly shorten the work of multiplying by a circulating decimal. To a student who has learnt, by previous observation, that '8 = 1, the above working needs no explanation.

The difficulty in multiplying by the circulating decimal may also

be avoided by the method following:-

$$25.708\mathring{s} = \frac{25.708\mathring{s} \times 3}{3}$$

$$= \frac{77.125}{3}$$
... 25.15 francs $\times 25.708\mathring{s} = \frac{25.15}{3}$ francs.
$$= \frac{1939.69375}{3}$$
 francs.
$$= 646.56458\mathring{s}$$
 francs.

In this case, the key to the method is the fact that any decimal number which ends in 3 may be made into a non-recurring decimal by multiplying it by 3; so also may a decimal number ending in 6.

Example CXIV.

If 10 thalers = 37.4 francs; 10 gulden = £1; £10 = 46 scudi; and 100 gulden = 253 francs; how many thalers are worth 51 scudi?

By Chain Rule.

10 thalers = 37.4 francs.
253 francs = 100 gulden.
10 gulden = £1.
£10 = 46 scudi.
51 scudi =
$$x$$
 thalers.
10 × 253 × 10 × 10 × 51
= 75
∴ $x = \frac{10 \times 253 \times 10 \times 10 \times 45}{37.4 \times 100 \times 46}$
∴ Answer = 75 thalers.

N.B.—The student will find it convenient to test his answers, whenever possible, by comparing them with the question. In this way he will detect gross mistakes, if there be any, at a glance. For example, let us test the answer 75 thalers.

By the question we see that 100 gulden = 253 francs;

- ... 10 gulden = 25 3 francs;
- i.e. £1=25·3 francs. .: 10 thalers (or 37·4 francs=about $1\frac{1}{2}$ of 25·3 francs)=about £1 $\frac{1}{2}$.
- ... 75 thalers = £1\frac{1}{2} \times 7\frac{1}{2} = a little over £11.

Now £10=46 scudi; £11=46 scudi \times 11

=50.6 scudi;

.. a little over £11=51 scudi,

i.e. 75 thalers = 11 scudi, and this agrees with the terms of the question.

Example CXV.

[Civil Service Papers.]

A and B starting at opposite corners of a square, whose side is 100 yds. long, walk round it in the same direction; A walks 19 yds. while B walks 16; at what part of the square will they be together, and what number of times will each have passed the corner from whence he started?

B ______P

Let A and B be the points from which A and B start respectively, and let the direction in which they move be indicated by the arrows.

- (i.) Before A overtakes B he will have to gain 200 yds. upon him; Now when A has walked 19 yds. he has gained 3 yds.;
 - ... to gain 200 yds. he must walk $\frac{200 \times 19}{3}$ yds., i.e.

 $1266\frac{3}{2}$ yds. = 100 yds. × $12\frac{3}{2}$. But the distance round the square = 400 yds.

... A must have travelled 3 times round the square, and \ of the

distance from A to P.

(ii.) While A travels 19 yds., B travels 16 yds.;

... While A travels 12663 yds., B travels 15 of 12663 yds., i.e. 10663 yds., i.e. twice round the square, and 2663 yds. farther. Therefore, counting the starting as once, A will pass point A four times, and B will pass point B three times, and they will be together at a point situated twice as far from A as it is from P. Answer.

Example CXVI. [Civil Service.]

A person shooting at a target, distant 550 yds., hears the bullet strike the target 4 secs. after he fires. A spectator, equally distant from the target and the shooter, hears the shot strike the target 21 secs. after he hears the report. Find the velocity of sound.

Let T represent the Target. the Marksman. \{ M......S......T the Spectator. Then the distance MT = 550 yds. = 1650 ft.

The time required for the bullet to travel from M to T+the time required by the sound to travel from T to M=4 secs.

Now a person at S hears the report at M as long after the explosion

occurs as the sound would take to travel from M to S;

Therefore. The interval between the reports reaching S and the actual occurrence of the collision at T is less than the time occupied by the passage of the bullet over the distance MT, by the time required for sound to pass over the space MS.

Again, in order that the report of the collision at T may reach the spectator at S, the sound must pass from T to S; but to reach the marksman at M, it must travel the distance TM; difference=SM.

Therefore, the 11 secs. (which is the difference between the periods, 4 secs. and 21 secs., given in the question) is the time occupied by sound in travelling over twice the distance MS; i.e., the distance MT; i.e., 1650 ft.

... The velocity of sound per second = $\frac{1650 \text{ ft.}}{11}$ = 1100 ft. Ans.

Example CXVII.

A train, consisting of nine carriages and an engine, each 30 ft. long and 2 ft. apart, and travelling 10 miles per hour, is overtaken by a similar train proceeding at 15 miles per hour. At what intervals of time will the carriages of the one train be brought exactly alongside those of the other?

- (i.) The speed of the quicker train per hour is 5 miles more than that of the slower;
- (ii.) By making a diagram, the student will see that in order to bring the carriages successively alongside, it is necessary that the quicker train should gain 32 ft.

Therefore

5 miles: 32 ft.:: 60 minutes: Answer.

$$\therefore Answer = \frac{60 \text{ minutes} \times 32}{5 \times 1760 \times 3}$$

$$= \frac{4}{65} \text{ min.}$$

Example CXVIII.

Two houses stand side by side, one being built of bricks which are $5\frac{\pi}{4}$ inches thick, and the other of freestone blocks which are $11\frac{1}{4}$ inches thick. The front walls are $56\frac{\pi}{4}$ feet high. How many times will the pointing of the front walls of the two houses be in the same straight line?

(i.) It is first necessary to find the L.C.M. of 5\frac{2}{3} in. and 11\frac{1}{4} in.

5\frac{2}{3} \times 5 = 27\frac{1}{3} \times \text{the L.C.M.} of 27 and 45 will be the L.C.M. of and 11\frac{1}{4} \times 4 = 45\frac{1}{3} is the L.C.M. of 5\frac{2}{3} and 11\frac{1}{4}.

Therefore, the pointing of the one house will correspond with that of the other house, at intervals of 135 inches.

(ii.) Therefore Answer =
$$\frac{56\frac{1}{4} \text{ ft.}}{135 \text{ in.}}$$

= $\frac{(56\frac{1}{4} \times 12) \text{ inches.}}{135 \text{ inches.}}$
= $\frac{225 \times 12}{4 \times 135}$
= 5

Example OXIX.

What is the least number of geography books $\frac{3}{4}$ in. thick, and history books $1\frac{1}{3}$ in. thick, which must be piled in respective columns in order to make a perfectly level surface with a number of Bibles which are $1\frac{3}{4}$ in. thick?

(i.) Find the L.C.M. of $\frac{2}{5}$, $1\frac{1}{5}$, $1\frac{1}{5}$.

$$\begin{array}{l}
\frac{3}{1} \times 4 = 3 \\
1\frac{1}{3} \times 3 = 4 \\
1\frac{3}{1} \times 5 = 8
\end{array}$$
L.C.M. of 3, 4, 8 = L.C.M. of 3, 1\frac{1}{3}, 1\frac{1}{3}, 1\frac{1}{3}, 1\frac{1}{3}, \frac{1}{3}, \frac{1}, \frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{1}{

Therefore, the height of the surface required is 24 inches.

(ii.) Now 24÷ \$\frac{1}{2}=32\$, the number of geography books.
 Answer.

Example OXX.

I am thinking of buying three pieces of land, and I find that the price of the first and third together would be $\frac{9}{8}$ that of the second, while the price of the first and second together would be $\frac{4}{8}$ that of the third. The first piece alone would cost £66. What will be the price of the three pieces in all?

Let A represent price of first piece.

B ,, second piece.
C ,, third piece.

C ,, third piece.

A + C =
$$\frac{1}{8}$$
 of B.

i.e., £66 + C = $\frac{1}{8}$ of B.

$$\therefore$$
 £66 + C = $\frac{1}{8}$ of C.

£66 + B = $\frac{1}{8}$ of C.

£66 + B = $\frac{1}{8}$ of C.

$$\therefore$$
 £66 = ($\frac{1}{8}$ of C) - B.

Combining (i.) and (ii.), we get

($\frac{1}{8}$ of B) - C = ($\frac{1}{8}$ of C) - B.

$$\therefore$$
 ($\frac{1}{8}$ of B) + B = ($\frac{1}{4}$ of C) + C.

$$\therefore$$
 3 B = 8 C,

or, B = $\frac{8}{3}$

Now, by (ii.) we have
$$\pounds 66 + B = 4\frac{1}{3}$$
 of C.
i.e., $\pounds 66 + \frac{8}{3} = 4\frac{1}{3}$ of C.
 $\therefore \pounds 66 = (4\frac{1}{3} \text{ of C}) - \frac{8}{3} = \frac{2}{3}$ of C.
 $\therefore \pounds 33 = C$.
And, by (i.)
$$A + C = \frac{1}{3} \text{ of B.}$$
i.e., $\pounds 99 = \frac{1}{3}$ of B.
i.e., $\pounds 99 = \frac{1}{3}$ of B.
i.e., $\pounds 99 = \frac{1}{3}$ of B.
i.e., $\pounds 98 = \pounds 88 + \pounds 33$.
 $\pounds £187$.

Example CXXI.

A person invested part of £20,000 in 3 per cent. stock at 85, and the remainder in 4 per cent. stock at 115. He finds that if he had invested 391 times as much in each kind of stock his annual income would have been £274,900. What amount did he actually invest in each kind of stock?

And, therefore,

the average rate per cent. on his investment = $\frac{274,900}{391 \times 200}$ = $\frac{2749}{790}$

 $=\frac{2143}{782} = 3\frac{143}{12}.$

(ii.) Now, the real rate per cent. obtained by investing in the 3 per cents at $85 = \frac{100}{85}$ of 3

And the real rate per cent. obtained by investing in the 4 per cents at $115 = \frac{100}{115}$ of 4

$$\begin{array}{r}
115 \\
= 3\frac{1}{2}\frac{1}{3} \\
= 3\frac{1}{2}\frac{1}{3}.
\end{array}$$

```
(iii.) Combining (i.) and (ii.) we find that
                                    (A.) Every £100 invested in the 3 per cents gives an
                                                              annual income which is [3\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}
                                                              the average income on that sum
                                      (B.) Every £100 invested in the 4 per cents gives an annual income which is [3400 - 3414, i.e.] 100 below
                                                              the average income on that sum.
                        But the excess obtained in the one stock is balanced by the
                             `loss in the other:
                        ... Since the excess of income obtained by investing a given
                               sum in the 3 per cents: the less by investing an equal sum
                        in the 4 per cents :: \frac{1}{113} : \frac{20}{113}, it follows that, when the excess in the one case balances the
                               loss in the other, the sums invested are in the inverse pro-
                               portion of the gain and loss respectively;
... the aum in-
vested in the vested in the per cents. : { loss per cent. in the 4 per cents. } : { gain per cent. in the 3 per cents. } : { gain per cents. }
       in other words.
                     the sum invested in the 3 per cents. the 4 per cents.
                                                                          N.B.-£29:£11=29 tons:11 tons
                                                                                                                          or, 29 miles: 11 miles
                                                                                                                          or, 29 thousands: 11 thousands
                                                                                                                          or, 29:11
                                                                           In the same way,
                                                                                                        29 fifths : 11 fifths = 29 : 11
                                                                                  and also
                                                                                                                       \frac{20}{100}: \frac{21}{100} = 29:11
                         We have, therefore,
                                the sum invested in the 3 per cents. : { the sum invested in the 4 per cents. } :: 29 : 11
```

Therefore,

Out of every £40 invested, £29 were invested in the 3 per cents and £11 in the 4 per cents;

The answer will therefore be found by dividing the £20,000 into two parts, which shall be to each other as 29: 11

 $\therefore Answer = \begin{cases} £14500 \text{ invested in the 3 per cents} \\ \text{and } £5500 \end{cases}, , , , 4 ,,$

Exercise 67.

- *1. The estate of a bankrupt, £21,000, is to be divided among four creditors, whose debts are—A's to B's as 2:3, B's
 - Dublin University Examination Papers, 1868.

to C's as 4:5, C's to D's as 6:7; what must each receive?

- *2. Lead is 14.5 as heavy as water, and a cubic foot of water weighs 62.3 lbs. avoirdupois; from these data calculate the weight of a leaden sphere the radius of which is 9 inches.
- *3. Find the cube root of \$ to seven places of decimals.

*4. Reduce to its simplest form-

$$\frac{3+\sqrt{5}}{3-\sqrt{5}} \times \frac{8-\sqrt{20}}{8+\sqrt{20}}$$

†5. One room contains 18 sq. yds., 3 sq. ft., 19 in.; a second, 42 sq. yds., 8 ft., 11 in.; a third, 29 sq. yds., 5 ft., 100 in. What must be added or subtracted in each case to make the rooms of the average size?

6. A silversmith made a certain number of tea-spoons weighing 26 lbs. 10 oz. 13 dwts., and a certain number of tablespoons weighing 38 lbs. 10 oz. 11 dwts. 18 grs.; find the cost of all the spoons at £3, 17s. 11d. per oz.

State the different methods employed in subtraction, and give your reasons for preferring one of them to another.

7. A farmer rents a farm of 400 acres on the following terms: He pays as rent 100 qrs. of wheat, 75 qrs. of barley, and 60 qrs. of oats, the price of wheat, barley, and oats being respectively 49s. 6d., 30s. 8d., and 19s. 2d. per quarter. Give his average rent per acre in £ s. d.

Make out the following bill:—5 tons of coal at 15s. 6d. per ton, carriage of same at 2s. 6d. per ton—2 trucks of gravel (i.e. 11½ tons) at 5s. per ton, carriage of same at 2s. 6d. per ton.

What are the two different kinds of *practice* called? Which kind is mostly used in bills of parcels? Give reasons for your answer.

Find the change out of a £10 note after paying the following bill:—12½ yds. of flannel at 1s. 6d. per yd., 37 yds.

* Dublin University Examination Papers, 1868.

† Questions 5 to 20 are taken from the Examination of Female Candidates for admission into Training Colleges, Midsummer 1882.

of calico at 1s. 0\frac{1}{2} per yd., 21 yds. of muslin at 2s. 4\frac{3}{2}d.

per yd., 18 yds. of linen at 2s. 6d. per yd.

What is a Bill of Parcels? What else is it sometimes called? What rules of mental arithmetic can be applied in finding the amounts of the items?

10. Find by practice the rent of 311 acres 3 roods 26 perches

at 5s. 81d. per rood.

What rule does practice depend upon? And how is that

rule simplified by it?

11. A bankrupt can pay only 12s. 6d. in the pound, and his debts amount to £1537, 3s. 4d.; what is his estate worth? How much will be paid on a debt of £276, 11s. 6d. ?

What is meant by an "aliquot" part?

12. The planting of a rood of ground cost £28, 8s. 4d.; what was paid for planting 23 acres, 3 roods, 24 perches, and 11 sq. yds. ?

Explain and define measure, factor, multiple, sub-multiple,

13. Bought 176 yds. 2 qrs. 2 nails, 1½ in. at 18s. 9d. per English ell (=5 quarters); what is the gain or loss in selling at 6d. per inch.

Explain the terms profit and loss—profit and loss per cent.

14. If the road in front of a row of houses, three-quarters of a mile long, be repaired at a cost of £7, 9s. 6d., what portion of the expense should be paid by an inhabitant whose premises have a frontage of 18 yds. 2 ft. ?

Explain the difference between "ratio" and "proportion." How many kinds of proportion are there? State and explain the names given to the several parts in a propor-

tion sum.

15. An engine of 16 horse-power can pump out 2 ths of the water in a reservoir in 3 days, working 7 hours a day. In how many days will an engine of 15 horse-power, working 8 hours a day, empty the reservoir?

By what methods can the work be shortened in a proportion sum? Explain why these methods are correct.

16. Two-sevenths of a farm is sown with wheat, four-ninths of it is pasture, and the remainder, woodland, contains 24 acres, 2 roods, 7 perches. Find the size of the farm.

What is a fraction? Name the different kinds of vulgar

fractions, and distinguish between them.

17. If the owner of $\frac{4}{17}$ ths of a ship sold $(\frac{3}{11}$ of $\frac{2}{9})$ ths of his share for £\(\frac{4000}{33}\), what was the value of $(\frac{1\frac{1}{4}}{4\frac{1}{4}}\) of <math>\frac{2}{6})$ ths of the whole ship at the same rate?

Give and explain the names of the different parts of a vulgar fraction, and show their relations to each other,

and to the integer.

18. How much will remain of \(\frac{7}{2} \) of £25.2, after the following articles have been paid for: viz. 1\(\frac{4}{2} \) yds. of cloth at £0.8 per yd., and 12.2 yds. of linen at £0.125 per yd.? Give the answer in decimal form.

Name the different kinds of decimals, and distinguish be-

tween them.

19. In what time will £436, 10s, amount to £568, 18·1s, at 7 per cent. per annum, simple interest?

Define principal, amount, interest (simple and compound),

discount, stocks, annuities.

20. A farmer mixes wheat; 9²/₅ qrs. at 38s. 6d., the same quantity at 40s. 6d., and at 42s. 9d. per quarter, and 24²/₅ qrs. at 45s., and the same quantity at 47s. per quarter. What is the average price of the mixture?

What is a percentage? an average?

APPENDIX.



APPENDIX.

EXAMINATION PAPERS.

Society of Arts Examination.

1880.

Paper 1.

[Three hours allowed.]

The working must be shown in all cases.

1. A man, by working 292 days 6 hours in the past year, has earned at the rate of 6s. 51d. per day of 10 hours. Find, by practice, the amount of the year's earnings.

2. Divide 111 into three parts in the proportion of \(\frac{1}{4}\), \(\frac{1}{6}\).

3. If 5 sovs. 7 flor. 4 mils. would be the value of 23 yards of silk, how many yards are worth £4, 15s. 7d.?

4. Find the amount, by compound interest, of £273, 13s. 8d. for

two years at 32 per cent. per annum.

5. Find a single vulgar fraction equivalent to $\frac{3}{16} + \frac{13}{28} + \frac{1}{40} - \frac{2}{3}$; and convert the result into a decimal of six places.

6. Simplify $\frac{-1}{9\frac{7}{12}}$ 13§ — 7§

7. What sum will yield £35, 18s. 5d. simple interest, in 3\frac{3}{4} years,

- at 3½ per cent. per annum?
 8. Find the true and also the mercantile discount on £56, due eight months hence at 71 per cent. per annum; and show that the mercantile discount exceeds the true discount by the interest of the true discount.
- 9. A merchant bought 16 puncheons of brandy at 207 francs per puncheon, and sold 11 puncheons of it at 231 francs; at what price must he sell the remainder to gain 12½ per cent. on the whole?

10. If by selling cotton at the rate of 484 francs for seven bales, a trader gains 4½ per cent., what will be his gain per cent. by selling it at the rate of 616 francs for nine bales?

11. Calculate by practice 30095 of £2, 12s. 6 d.

12. Divide £69, 11s. 6d. into three parts, making the first a guinea more than the second, and the second half-a-sovereign less than the third.

13. A father, being five times as old as his son, is 42 years older

than his son; what is the boy's age?

14. Bought a joint of beef weighing 13½ lb., and a leg of mutton weighing 9 lb. 6 oz.; the beef came to 4s. more than the mutton, and the two joints together to 19s. 7½d. Make out a bill, specifying the prices per lb.

15. What rate per cent. interest is obtained by investing £370 in

31 per cent. stock at 80?

16. A person invested £460 in 3½ per cent. stock at 80½; what sum was invested in 4½ per cent. stock at 102% by another person who obtained thereby the same amount of income?

17. Suppose the price of an article to be 7.27 per cent. cheaper now than it was formerly; how much per cent. dearer was it for-

merly than it is now?

- 18. The cost price of a quantity of goods is £10, 4s. 3d.; at what rate per cent. profit must they be sold, that the greatest common measure of the cost price and selling price may be 10s. 9d., and their least common multiple £234, 17s. 9d.?
- 19. A pianoforte was sold at a profit of £9, 16s.; and it was observed that one-seventh of the number of pounds in the cost price was one-ninth of the number of guineas in the selling price. Find the cost price.
- 20. A person invested part of £1000 in $3\frac{1}{2}$ per cent. stock at 80, and the remainder in 5 per cent. stock at 112, and his joint income from both was £44, 1s. 3d. What was the amount of each investment?

Examination in the Schools for the Education of the Children of Wesleyan Methodists.

Paper 2.

UPPER SCHOOL EXAMINATION.

JUNE 1876.

1. How many times are 9 lbs. 13 dwts. 21 grs. contained in 135 lbs. 10 oz. 8 dwts. 3 grs.; and 7 sq. ft. 38 sq. ins. in 8 poles 19 sq. yds. 4 sq. ft. 72 sq. ins.?

- 2. Simplify $\frac{26\frac{3}{5}-1\frac{13}{2}}{\frac{1}{5}-\frac{1}{3}+\frac{3}{5}}$ and reduce $\frac{5}{6}$ of £44, 17s. to the fraction of £292.
- 3. If $\frac{1}{3}$ of my possessions consists of land, $\frac{1}{24}$ of Government stock, and the remainder which is in the bank is £352; what am I worth?

Find the cost of 1734 articles at £11, 19s. 10½d. each. Also of

1 ton 3 qrs. 16 lbs. at £11, 11s. 6d. per cwt.

5. If a boy does half as much work as a woman and one-third as much as a man, and 15 men 12 women and 10 boys complete a piece of work in 300 days; in what time will 20 men 14 women and 15 boys finish the same?

6. Multiply 2.546 by 00042 and divide 01 by 1001 and 8.01504

by .099.

7. Reduce £2, 13s. 7½d. to a decimal of £10; 30455 to a vulgar fraction; and find the value of 1469 of a furlong.

8. Find the compound interest on £250 for 2½ years at 5 per cent. At what rate per cent, will £184 amount to £213, 18s. in 3½ years simple interest?

9. An increase of 10d. in the price per lb. makes a difference of 8 in the rate per cent. of profit. At what price must a cwt. be sold

so as to gain 15 per cent. ?

10. A gentleman delays making an investment in consols, and by so doing gains 3s. 2d. of annual income by the funds falling from 91½ to 90½. Find the sum invested.

11. A man rows a distance of $6\frac{1}{2}$ miles in 2 hrs. 36 min. against a stream running at the rate of $2\frac{1}{2}$ miles an hour. How long would

he have taken to row the same distance with the stream?

12. The weight of a cubic inch of water is 252:458 grains. Find the percentage of error that arises from taking a cubic foot to weigh 1000 ounces.

Paper 3.

LOWER SCHOOL EXAMINATION.

June 1876.

Add together eighty millions sixty-seven thousand and eighteen;
 nine millions seven hundred and sixteen.

2. Multiply 56,380,477 by 35, and 67,836,479 by 78,539. Divide

935,384,767 by 37, and 237,876,093 by 5605.

3. Reduce £127, 16s. 8 dd. to farthings; 89 tons 17 cwt. 27 lbs. 15 oz. to ounces; 95 gall. 1 pt. 2 gills to gills.

4. Multiply £9, 10s. 11½d. by 86; and divide 85 ac. 3 r. 27 po.

8 yd, 8 ft. 45 in. by 246.

5. Find the nearest sum of money to £197, 11s. 6d. that can be divided by 23 without remainder. How many sovereigns, half-sovereigns, crowns, florins, shillings, sixpences, and threepences, and of each an equal number, are there in £67, 16s. 3d.?

6. Find the greatest common measure of 93,883 and 166,581, and

the least common multiple of 7455 and 18,744.

7. Reduce to lowest terms \$\frac{233567}{436263}\$ and \$\frac{256417}{7010117}\$ and arrange in order of magnitude \$\frac{1}{25}, \frac{2}{1}, \frac{1}{25}\$.

8. Simplify
$$\frac{3+\frac{5}{8} \text{ of } \frac{21}{7\frac{5}{8}} - \frac{1}{4} - \frac{1\frac{3}{8}}{2\frac{1}{4}}}{10 - \frac{1}{2}\frac{5}{8} \text{ of } 5}$$
 and $\frac{1\frac{8}{13}}{1\frac{3}{3}}$ of £8, 8s. $5\frac{1}{4}$ d. $-\frac{3\sqrt{1}}{4\frac{3}{8}}$

of $\frac{10\frac{8}{7}}{7\frac{1}{8}}$ of £2, 0s. 6d.

9. Divide 0003738028 by 0476 and multiply 43 291 by 6.24. Add together 03125 of £20 + .729 of 6s. 2d. + .729 of £2, 1s. 3d.

10. Find by practice the cost of 17 tons 12 cwt. 3 qrs. 18 lbs. at

£6, 15s. 9d. per cwt.

11. If 37 tons are carried 57 miles for £8, 15s. 9d., what weight

can be carried 83 miles for £21, 15s. 9d.?

12. Find the simple interest on £654, 2s. 6d. for $4\frac{1}{2}$ years at $4\frac{1}{2}$ per cent.; and the present worth of £1250, 10s. due $2\frac{1}{2}$ years hence at $3\frac{1}{2}$ per cent.

College of Preceptors' School Examinations.*

CHRISTMAS, 1880.

Examiners-P. MAGNUS, B.Sc., B.A., and E. PINCHES, B.A., L.C.P.

Paper 4.

UNITED WESTMINSTER SCHOOLS-THE DAY SCHOOL.

UPPER THIRD AND LOWER FOURTH.

1. Multiply 23,417 by 3152, and verify the result by division.

2. A man's income is £94, 5s. 10d. the year; how much does he get every day?

* These papers show what may fairly be expected of the children in a good middle-class school.

3. A cask of wine fills 23 dozen bottles, and 6 bottles make up a gallon; how many gallons of wine are contained in the cask?

4. If a pint of wine is worth 1s. 3d., what is the value of the cask

of wine in the previous question?

5. Simplify $\frac{3}{5} + \frac{2}{4} + \frac{4}{5} + \frac{5}{6} + \frac{7}{12} + \frac{3}{20}$.

6. Simplify $2 + \frac{1}{4+1}$; and find the remainder left on dividing 50,000,000 by 21.

7. If a man walk 11 yards in 6 seconds, in how long a time will

he walk 19 miles?

8. Find the value of a parcel consisting of 20 gross of pens at 4d. the dozen, 500 quires of paper at 3s. the ream, 17th lbs. of wax at 1s. 6d. the lb., and a pint and a half of ink at 5s. 6d. the gallon.

Paper 5.

UPPER AND MIDDLE FOURTH.

[Not more than eight questions to be answered. Boys of the Upper Fourth to do the last eight questions.]

1. A man purchases 217 yards of cloth at 6s. 8d. the yard. paying for it till 21 years after the purchase, he is charged simple interest at the rate of 5 per cent. What is the whole amount he pays for the cloth?

2. Find the value of $\frac{2}{7}$ of a guinea $+\frac{5}{18}$ of £3, 15s. Od. $+\frac{7}{10}$ of

£8, 5s. 0d.

3. If a block of zinc, weighing 3 cwt. 14 lbs., is worth £5, 16s. 8d., find the value of $2\frac{1}{2}$ lbs. of zinc.

4. Simplify $\frac{3}{3} + \frac{5}{4} + \frac{5}{8} + \frac{5}{8} + \frac{7}{12} + \frac{7}{20}$.

5. Multiply $3\frac{2}{8}$ by $4\frac{2}{7}$, and divide the product by the sum of $3\frac{1}{4} + 2\frac{1}{6} + \frac{1}{6}$

6. If a man walk 11 yards in 6 seconds, in how long a time will

he walk 19 miles?

- 7. If 3 men can write 72,000 words in 2 days, working 8 hours a day; how many words can 4 men write in 3 days, working 5 hours a day?
- 8. Simplify $2 + \frac{1}{4 + \frac{1}{k}}$, and reduce the result to a decimal correct to 7 places of decimals.

9. One metre measures 39.37 inches. Reduce 5.75 metres to

yards, feet, and inches.

10. Reduce to decimals the following vulgar fractions: - 120, 35 1 180 82000.

Paper 6.

FIFTH.

1. Find the value of $\frac{3}{4}$ of a guinea $+\frac{5}{18}$ of £3, 15s. 0d. $+\frac{7}{10}$ of £8, 5s, 0d.

2. A man sells a house for £2350, and gains 8 per cent. on its

cost price; what did he give for the house?

3. If a block of zinc, weighing 3 cwt. 14 lbs., is worth £5, 16s. 8d.,

find the value of $2\frac{1}{2}$ lbs.

4. If 20 nuts can be exchanged for 3 apples, and 48 apples for 3 lbs. of grapes, and if 2 lbs. of grapes can be exchanged for 16 pears; find the price of 100 nuts, if pears are sold at the rate of 4 for sixpence.

5. Reduce to decimals the following vulgar fractions:—

120, 256, 1760, 32800. 6. In how long a time will £2140 amount to £3080 at 4 per cent. simple interest.

7. Simplify $\frac{2\frac{1}{3}+3\frac{1}{4}-4\frac{1}{5}}{\frac{7}{5}+1\frac{3}{5}-\frac{4}{5}} \times 2\frac{1}{5}$.

8. A vessel 4 feet long, 1 foot deep, and 1 foot broad, is filled with water, and is found to weigh 275 lbs., the weight of the vessel being 25 lbs.; find the weight of a cubic inch of water.

9. Find, approximately, the value of 3 tons 2 cwt. 17 lbs. of metal

at £24, 13s. 6d. the ton.

Paper 7.

SIXTH.

[Not more than eight questions to be answered.]

1. Simplify $\frac{16+64+64}{81+225+625}$

2. At what times between 4 and 5 o'clock are the hands of a

watch together?

3. A man buys goods for £235, 12s. 6d. At what price must he sell them, after 2 months, in order to gain a profit at the rate of 20 per cent. per annum?

4. Find the value of a bar of gold weighing 2 lbs. 3 oz. at £3, 17s.

 $10\frac{1}{3}$ d. the oz.

5. If £1 is worth 25½ francs, find the value in francs of 100 lbs. of silver at 4s. 2d. the oz.

6. Determine the compound interest on £2763 for 3 years, at

4 per cent., payable half-yearly.

7. Which is the better investment—a 4½ per cent. stock at 102,

or a 5 per cent. stock at 112?

8. Find what sum a man must invest in a 3 per cent stock at $97\frac{1}{4}$, so that, after paying 6d. in the pound income tax, he may have a net income of £2000 a year.

9. Simplify, without reducing to vulgar fractions,

$$\frac{0.001}{50} + \frac{2.4}{0.012} + \frac{0.72}{0.006} + \frac{0.05}{2.5} + \frac{3.5}{700}.$$

10. Find the cost of covering with carpet a room that is 22 feet long and 18 feet 1 inch broad, the width of the carpet being 31 inches, and the cost 5s. 3 d. the yard.

11. Write down the following sums of money as decimals of £1, correct to 5 places:—£3, 17s. 10½d., £2, 1s. 1½d., £4, 2s. 3¾d.,

£1, 0s. $7\frac{1}{2}$ d., £6, 2s. $2\frac{1}{2}$ d., £11, 1s. $0\frac{4}{2}$ d.

12. If I lb. avoirdupois contain 7000 grains troy, express a pound troy as a decimal of a pound avoirdupois.

Miscellaneous Exercises Selected from Pupil Teachers' Examination Papers.

Paper 8.

From the NOVEMBER PAPER, 1876.

1. Add together £175, 17s. 6d., 500 guineas, 87 half-crowns, and 1143 fourpenny pieces.

2. The annual rent of a parish is £13,793, and the poor rate is

2s. 7dd. in the pound; to how much does the rate amount?

3. How much money shall I have left if, after being paid an average price of $47\frac{1}{2}$ guineas each for 17 horses, I buy 374 qrs. 7 bush. 2 pks. of wheat at £2, 3s. 8d. a quarter?

4. If 24 oxen require 6 acres of turnips to supply them for 10 weeks, how many acres would supply 6 score of sheep for 15 weeks,

3 oxen eating as much as 10 sheep?

5. Make out the following bill:—8 doz. and 8 eggs at 1s. 1½d. per doz.; 17½ lbs. of butter at 1s. 3d. per lb.; 6½ lbs. of cheese at 9d. per lb.; 13 lbs. of soap at 4½d. per lb.; 15 lbs. of lard at 7¾d. per lb.

6. What weight must be added to $\frac{3}{5}$ of $\frac{3}{14}$ of half a cwt. to make it up to 👸 of 3‡ quarters avoirdupois?

7. What is the value of 3 quarters of oats if 17# quarters cost

£33.5. ?
8. I bought 14 cwt. 3 qrs. 14 lbs. of clover at £2, 5s. 44d. per cwt.; at what price per cwt. should I sell it to gain £6.8796875 on my

bargain?

9. Two watermen rowing with a tide flowing at the rate of 21 miles an hour get over 20 miles in 3.2 hours; in what time could they do the distance against the same tide? Give answer in decimals of an hour.

Find the cost of 183½ yds. of cloth when 2½ yds. cost a guinea.

11. If 3 men can dig a ditch 105 yds. long 4 ft. deep and 5 ft. wide in 10 days, how long will it take 5 men to dig a ditch 175 yds. long 41 ft. deep and 6 ft. wide?

12. Reduce $31\frac{1}{12}$ of 3 days 7 hours to the fraction of 3 weeks, and

24 of 14 lbs. to the fraction of 3 qr. 10 lbs.

- 13. What number added to $1\frac{7}{10}$, $3\frac{9}{16}$, $2\frac{1}{10}$, $\frac{5}{24}$ will make the sum total 10?
- 14. Of a field 1 is meadow, 3 is arable, and the remainder is 1 ac. 3 r. 26 po.; find the quantities of meadow and arable land.

15. Reduce to a simple form

$$\begin{array}{c} 2\frac{1}{8} \text{ of } \frac{18}{2\frac{1}{8}} \cdot \frac{18}{18} + \frac{11}{18} \\ \frac{1}{8} + 1\frac{2}{17} \cdot \frac{8}{18} \text{ of } 1\frac{1}{19} \end{array}$$

16. If the interest of £540, 10s. for 1 year be £1, 7s. 6d., what

principal will yield the same sum in 2½ years?

17. Four and a half years ago £2785, 16s. 8d. was lent at simple interest, and it now amounts to £3538, Os. 2d.; what was the rate of interest?

18. What do I gain or lose per cent. by selling butter at 81d. per

lb. which cost £5, 5s. per cwt. ?

19. Find the value of '1236 of 2 acres, and reduce the result to the decimal of $3\frac{1}{2}$ roods.

20. From 2000 subtract 852-2534, and divide the remainder by

16·38.

21. A person is able to travel 142.2 miles in 41 days of 10.164 hours each; in how many days of 8.4 hours each can he travel 505.6 miles?

22. Selling apples at 3 for a penny I gain 5 per cent. What do

I gain or lose per cent. by selling them at £1 per 1000?

23. A customer lodged £350 in a bank which offered interest at 41 per cent. per annum. What sum did he claim at the end of 6 years 10 months, simple interest?

24. What is the compound interest on £375 for 3 years at 5 per

cent. per annum, interest payable half-yearly? (Answer to four places of decimals only.)

25. Find the interest on £8297, 13s. 6d., at 5\(\frac{1}{2}\) per cent. for 17

26. A can reap a field in 5 days and B in 6 days, working 11 hours a day; in what time could A and B together reap it, working 10 hours a day?

27. Find the value of 4.4 of a guinea - 3.75 of half-a-crown +

£:416 - :3571428 of a guinea.

28. Twenty-one thousand five hundred effective men remain out of an army of which '16 died in battle, '1 had been taken prisoners, and ·1361 were in hospital. What was the original strength of the army?

29. What is the amount of £400 for 4 years at 4 per cent. per

annum, compound interest?

30. A receives from D a certain quantity of flax at 61d. per lb., and 750 lbs. of cotton at 4:416d. per lb., and in return gives D 36 gallons of whisky at 8s. 9d. per gallon, and 10 guineas in money. What was the number of lbs. of flax received?

Paper 9.

FROM THE MARCH PAPER, 1877.

1. Find the difference between 49 tons 2 qrs. 17 lbs. and 50,917 ozs.

2. If potatoes are sold at £3, 14s. 8d. per ton, what quantity can be bought for 1d.?

3. What is the drainage tax on 780 ac. 3 ro. 16 po. at 10s. 6d. per acre?

4. A man buys coals at 1s. $1\frac{1}{2}$ d. per cwt. and sells them at £1, 5s. per ton. How many tons must be sell to gain £1, 12s, 6d.?

5. I bought cloth at 7s. 6d. a yard; at what price must I sell it

to gain 25 per cent.?

6. If a man travel 45 miles in 12 days by walking 8 hours a day, in what time will he travel 540 miles by walking 6 hours a day?

7. Reduce $\frac{1}{10}$ of 10s. $+\frac{4}{10}$ of 5s. 3d. $+\frac{8}{10}$ of 2s. 6d. to the decimal of £1, 5s. 9d.

8. Simplify $\frac{17}{\frac{1}{2} + \frac{1}{3} + \frac{7}{3} + \frac{7\frac{1}{3}}{3\frac{1}{3}}$. 9. If the wages of 13 men for $7\frac{1}{4}$ days amount to £13, 7s. $0\frac{1}{2}$ d. how many men ought to work for 4 weeks for £173, 8s.?

10. If 3 of an estate is worth £450, 15s., what is the value of .48 of the estate?

11. How many times does the sum of 64 and 44 contain their difference?

12. What fraction of £37, 14s. 8\frac{1}{2}d. is equal to \(\frac{1}{2}\) of £296, 9s. 8\frac{1}{2}d.? 13. If \$\frac{2}{3}\$ of a yard of silk cost 4s. 11\frac{1}{2}d., find the cost of \$\frac{2}{3}\$ of \$\frac{2}{3}\$ of a yard.

14. A man who has a house worth £2000, insures it at \$ of its value at 3s. 4d. per cent. What does his yearly premium amount

15. Suppose that a reduction of 15 per cent. in a man's wages causes him to lose 1s. 6d. weekly; what were his weekly wages before the reduction?

16. A miller uses for a stone weight one that weighs only 13\frac{1}{2} lbs.

What does he gain per cent, by his dishonesty?

17. A gardener sows a drill 44 yds. in length with a quart of peas; the plant fails partly, and on transplanting he finds that he has a row of only 108 ft. long. What does he lose per cent.?

18. If I lend a friend £1250 at 4 per cent, simple interest, and tell him to keep it until principal and interest amount to £1666,

13s. 4d.; how long will he have it?

19. Divide the sum of 5.05 and 2.605 by their difference.

20. Find the difference between 2.3125 of 8s. and

$$\frac{3\frac{1}{6}}{1\frac{1}{13}}$$
 of $\frac{19}{120}$ of £2.

21. If a woman's profits are 3125 of her whole receipts, what was the cost price of a lot of eggs for which she receives 14s.?

22. If a pig and 17 rabbits cost £2, 11s. 3d., and the pig cost 8s. 9d. more than the rabbits; what would each of the rabbits cost?

23. A legacy of £2979, 12s. 6d. was left to four heirs in the proportion of \$\frac{1}{6}\$, \$\frac{3}{6}\$, \$\frac{4}{6}\$ and \$\frac{1}{6}\$. Find the share of each.

24. Divide the product of the sum and difference of 6 and 06

25. A bankrupt owes 3 creditors (A, B, and C) £290, £556, and £620 respectively; his property is worth £412, 6s. 3d. What ought each creditor to receive?

26. A £50 railway share, which cost me £55, pays a yearly

dividend of £6. What is my rate of interest?

27. One-fourth of an estate belongs to A, & of it to B, and the remainder to C, which is worth £2500 more than A's share. What is the value of the whole?

28. A field of grass is rented by 2 persons for £27; one keeps in it 15 oxen for 10 weeks, the other 21 oxen for 7 weeks. What rent

should each pay?

20. Find the square root of 8 and of 17% to four places of decimals.

Paper 10.

FROM THE JUNE PAPER, 1877.

1. What must be the length of a trench 5 ft. 6 in. deep and 10 ft.

8 in. wide, that it may contain 7040 cubic feet?

2. Light travels at the rate of 192,500 miles in a second; if the sun's light takes 8 min. 13 sec. in reaching us, what is his distance from the earth?

3. If 375 apples sell for 12s, what should be given for 1000

apples? and how many may be had for £1?

- 4. A dealer bought 207 sheep at £1, 3s. 6d. each, and sold 100 of them at £1, 4s. 10d. each, and the remainder at £1, 7s. 9d. each. What was his gain on the bargain?
- 5. If 5 men receive £5, 18s. wages for 12 days; what will be the wages of 16 men for 20 days?

6. If a carding machine throw off 54 lbs. of wool in 2 hr. 46 min.

30 sec., in what time will it throw off 24 lbs.?

7. The expenses of the poor in a parish amount to £110, 7s. 6d., and the rent is £2000. How much in the pound must be levied to pay it?

8. If 7 horses be kept 20 days for £14, how many can be kept 7

days for £28?

9. If 20 men can perform a piece of work in 14 days, required the number of men who could perform another piece of work, 3 times as great, in 1 part of the time.

10. Divide 7s. $1\frac{1}{2}$ d. by $\frac{1}{16}$ s, and subtract from the quotient $\frac{2}{3}$ s of

7 half-crowns.

11. Find the cost of 2625 of a mile at the rate of 9\frac{3}{4}d. per yd., and of 3.6 of 4 qrs. 4 bush. at £2, 16s. 6\frac{1}{4}d. per quarter.

12. Express $3\frac{1}{5}$ of £1, 0s. $9\frac{3}{5}$ d. as the fraction of (1) £1, 10s. 10d.,

and (2) of £5, 9s. $7\frac{1}{5}$ d.

13. One pound of sugar being worth 03515625 of £1, 12s., find the value of 15625 cwt.

14. Find the value of $5\frac{1}{3}$ of $4\frac{1}{2} - 3\frac{1}{4}$ of $3\frac{1}{2}$.

15. Divide
$$\frac{7(\frac{1}{2} \text{ of } \frac{3}{16})}{\frac{1}{6}(\frac{3}{3\frac{1}{6}} \text{ of } 7)}$$
 by $\frac{9}{14}$.

16. The dimensions of a room are 29½ ft. by 11½ ft. What length of carpet § yd. wide will cover it, and what will be the expense of it at 3½s. per yd.?

it at 33s. per yd.?

17. If \$\frac{1}{2}\$ of a ship be worth £36, 10s. 7\frac{1}{2}\text{d.}, what share will

cost £125, 5s.?

18. Cheese bought at £2, 10s. per cwt. is sold at 6½d. per lb. What is the gain per cent.?

19. How much per cent. is (a) 2½d. in the shilling, and (b) 2s. 9d. in the pound?

20. What vulgar fraction is equivalent to the sum of 14.4 and

1.44 divided by their difference?

21. Find the value of 347 of £3, 12s. 64d., and reduce the result to the decimal of £35, Os. 34d.

22. How many yards of matting 2.4 ft. broad will cover a floor

that is 27.3 ft. long and 26.16 ft. broad?

23. An agent gets £45, 12s. 6d. for selling goods at the rate of 21 What value of goods did he sell?

24. What sum must be invested at 2‡ per cent. for 3½ years, in

order to amount to £348, 12s. at simple interest?

25. A begins business with a capital of £1600, and at the end of 3 months takes B into partnership with a capital of £2000; at the end of 6 months more they divide the profits, amounting to £660. What sum should each partner receive?

26. Bought a quantity of quills at 4s. 7d. a hundred, and sold them so as to gain § of the selling price. What was the selling

price, and what was the profit per cent. on the cost price?

27. Three persons rent a field for £60, 10s. A puts in 5 sheep for 4½ months, B 8 sheep for 5 months, C 9 sheep for 6½ months. What must each pay of the rent?

28. The profits of a mine for one year amounted to £3296, 13s. $5\frac{1}{2}d$. and a person holding 14 shares received for his dividend the sum of

£1025, 12s. $7\frac{1}{2}$ d. How many shares were there in all?

29. Three hundred and sixty-three yds, are bought at 7s. 10 d. a yard, and of this quantity 1 is sold at 10s. 3d. a yard, 1 at 8s. 6d., and the rest at 7s. State, decimally, the percentage of profit or loss.

30. If gunpowder consists of 75 parts of nitre, 10 parts of sulphur, and 15 parts of charcoal, what weight of each ingredient will there

be in 15 cwt. of gunpowder?

31. The 3 per cents. standing at 98th, what sum must be invested in them to produce an annual income equal to the whole interest on

£500 for 14 years at $2\frac{1}{2}$ per cent.?

32. Find the interest on £34,675 for 17 days at 5 per cent. per annum, and distribute the interest among 3 persons, A, B, and C, in the ratio of 1, 11, and 21.

Paper 11.

FROM THE MAY PAPER, 1877.

1. A person bought 60 yds. of cloth at 5 yds. for £1, ls., and 70 yds. more at 7 yds. for £1, 1s.; he sold the whole at 6 yds. for £1, 1s. How much did he gain or lose?

2. Find the value of 2937 at 10 d. each.

3. Find the value of 44 ac. 2 ro. 25 po. at £55, 16s. 7 d. an acre.

4. Find the value of 2937 at £2, 11s. 10 d.

5. Find the value of 7 po. 27 sq. yds. of land at 2s. 4d. per square yard.

6. A bankrupt having £645, 5s. 3\d. left, can pay 7s. 8\d. in the

pound. What is the amount of his debts?

7. If 6 horses eat 18 guineas worth of hay in 6 weeks when hay is 9d. a stone, what is its price per stone when 15 horses eat £110, 5s. 6d. worth in 21 weeks?

8. Express 41 of £2, 5s. 31d. as a fraction of £4, 12s. 9d.

- 9. If \$\overline{e}\$ of a yard cost 4s. 11\dd., what is the cost of \$\overline{e}\$ of \$\overline{e}\$ of 4 yards of it?
- 10. A owns 567 of an estate, and B 6 of the remainder; what is the value of B's share if the whole estate be worth £27,000?

11. A person's salary is £191, 12s. 6d. for 365 days; in how many

days will he have a claim for £31, 10s. ?

12. If a man spend £152, 10s. every week, what must be his daily income that in 15 years he may lay by £7522, 10s.?

13. If 8 men, working 16 hours a day, can reap 9 acres in 3 days, how much land can 10 men, working 12 hours a day, reap in 3 days?

14. The wages of 27 men amount to £60, 15s. in 18 days; how many days must 76 boys work to earn £253, 6s. 8d., the daily wages of the latter being $\frac{2}{3}$ the daily wages of the former?

15. What number added to \$ will give 118? and what number

added to 1_{11}^{7} , 2_{16}^{7} , 3_{22}^{5} , and $\frac{9}{24}$, will make the sum 20?

16. What part of £2 is \$ of half a guinea?

17. A man owed £900 to 3 creditors, and his whole property amounted to £675. The claims of 2 of his creditors are £125 and £375 respectively. What sum will the remaining creditor receive for his dividend?

18. A can finish a piece of work in 2½ days, and B in 3½ days; if they work together what portion of the work will they finish in

1 day?

19. Find simple interest on £10,400 for 4 years 16 weeks, at 4 per cent. per annum.

20. The population of a town in 1857 was 15,786, and in 1877 it

was 19,670; what was the increase per cent.

21. Find the amount of £7506 at the end of $7\frac{1}{2}$ years, at $4\frac{3}{4}$ per cent. per annum, simple interest.

22. At what rate per cent, simple interest will £1248, 12s. amount in 2½ years to £1443, 13s. 10½d. ?

23. Simplify the expression :-

5 - 3.22 + 2.333 - 1.4444

24. There is a number which, when multiplied by 032, and the product divided by 0016, produces 815. Find it.

25. Find the values of £:5675, :375 cwt., and :6875 yds. (cloth

measure).

26. What percentage and what amount of interest will an investor receive, who puts his capital (£19,500) into the 3 per cents., standing at 897, commission being \(\frac{1}{2} \) per cent. ?

27. A cask of rum containing 78 gals. leaked 29 per cent.; what

quantity remained in the cask?

- 28. A, B, and C bought a patent, A taking $\frac{1}{3}$, B $\frac{1}{4}$, and C paying £52, 1s. 8d. for the remaining share. B received £2, 10s. per annum on his investment. What rate of interest was that per cent.?
- 29. If interest be paid at the rate of 3½ per cent. per annum, what sum of money, lent for 4 years at simple interest, would amount to £769, 10s.?

30. Find the simple interest and the amount of £417, 7s. 9d. for

1 year 10 months at 48 per cent.

31. By selling cheese at £3, 13s. 6d. a cwt., a grocer realised a

profit of 224 per cent. What did it cost him per cwt.?

32. The percentage of children who are learning to write is 65 in a school of 60 children, and 78 in another school of 70. What is the percentage in the two schools together?

33. The population of 3 towns in 1851 was 20,325, 42,405, and 1423, and in 1861 they had increased respectively 9, 10, and 12 per

cent. Find the average population of the 3 towns in 1861.

34. Certain £50 railway shares cost me £55 each, and yield a dividend of £6 a year each. What is the amount of my yearly income for every £100 invested, and what percentage of the income that I might have had, did I forego by not investing when the shares stood at their original price?

35. Bought 18 cwt. 3 qrs. 24 lb. of saltpetre at £1, 6s. 10d. per cwt., and sold $\frac{1}{2}$ of it at 3d. per lb., and the other $\frac{1}{2}$ at £1, 3s. 4d. per cwt. What did I gain or lose on the whole, and how much

per cent. ?

36. What is compound interest? State and explain the rule for finding the compound interest on a given sum, at a given rate, for

a given time.

37. If the price of beef in London be 11d. per lb., and 40 per cent. less in America, and if the cost of transport be \(\frac{2}{3}\)d. per lb., at what price could American beef be sold in London so as to realise 25 per cent. profit to the importer? and what would be the saving per cent. to the consumer at that price?

Paper 12.

FROM THE MARCH PAPER, 1880.

Make out the following bill :—

17 pairs of blankets at 8s. 9d. per pair. 14 pairs of stockings at 1s. 62d. per pair. 41 dozen pairs of gloves at 2s. 31d. per pair. 16 yards of cloth at 8s. 91d. per yd. 15½ lbs. of wool at 4½d. per lb. 19 yds. of lace at 2s. 7d. per yd.

2. Work, by practice,

(a.) The value of 6043 lbs. of tea at 3s. $2\frac{1}{2}$ d. per lb.

(b.) If sugar be bought at £1, 19s. 6d. per cwt., and retailed at 6dd. per lb., what is the profit on a cask containing 7 cwt. 1 qr. 14 lbs.?

3. Find the value of 2037 cwts. of sugar at £1, 19s. 8 d. per cwt. 4. If a man's yearly income is £194, 17s. 6d., what is due to him for 292 days?

5. If a bicyclist travel 42 miles in 4 hours 30 minutes and 30

seconds, how long will he be in going 147 miles?

6. What will be charged for flooring a room 23 ft. 6 ins. long, 16 ft. wide, at 51d. per square foot?

7. What will be the cost of conveying 17 tons 11 cwts. 3 qrs. weight of goods at 19s. $7\frac{1}{2}$ d. per ton?

8. I received £754, 5s. Od. for goods which cost £800; what was

the loss per cent.?

9. Two pieces of cloth of the same quality contain 54 yds. and 63 yds., and the longer is worth £1, 7s. Od. more than the shorter; what is the value of a third piece containing 120 yds.?

10. If 6 compositors set up a work of 6 sheets in 10 days, in what

time will 4 compositors set up a work of 12 sheets?

- 11. If 8 men earn £9 wages for 5 days' work, how much would 32 men earn for 24 days' work at the same rate?
- 12. Find the value of £1.9 + 7.45 shillings + 17.43 half-guineas + 85583 of £5.

13. Reduce \(\frac{2}{3} \) of $6\frac{1}{6}$ dwts. to the fraction of $3\frac{1}{6}$ lbs. troy.

14. What is the difference between \ of 17.163, and \ of 21.194?

15. Express 1 of 16 of 15 of 123 as a simple vulgar fraction.

16. Find the average of the following daily barometric readings:— 29.9, 30.1, 30.145, 29.93, 29.01, and 28.89. Give the answer in vulgar and decimal fractions.

17. Simplify the following:—

(a.)
$$\frac{\frac{1}{2} \text{ of } 2 \text{ of } 6\frac{7}{8}}{14}$$
.

(b.)
$$\frac{3}{4}$$
 of $5\frac{1}{9}$ of $\frac{1}{8}$.

18. Find the value of $\frac{2}{3}$ of $\frac{4}{5}$ of £158, 128.

19. The sum of two numbers is 33, and their difference is equal

to \$ of the greater; what are the numbers?

20. If it take 11 oz. of shot for a charge of a gun, how many shots can a boy have for 1s. worth of shot at 21d. a lb.? How much will be left in his bag after the last shot?

21. Find the simple interest of £1465, for $7\frac{1}{2}$ years at $3\frac{1}{2}$ per cent.

per annum.

22. What (a) decimal and (b) percentage of 1½ lb. troy is 1½ dwt.?
23. In how many years will £417, 10s. gain £125, 5s. at simple

interest 4 per cent. per annum ?

24. If a man lends a friend £1250 at 4 per cent. simple interest, and directs him to keep it till the principal and interest amount to £1666, 13s. 4d., how long will the friend have the money?

25. If I gain 111 per cent. on every egg which I sell for 1d., what

sum shall I gain on 413 dozen sold at that rate?

26. Divide 2.5 by .32; and 1 by .013.

27. Find the value of 375 of a guinea + 1875 of a crown +3 of **7s.** 6d. – ·875 of 2d.

28. If 1 lb. of sugar cost 0703125 of 16s., what is the value of '0625 cwt.?

29. Bought 18 cwt. 3 qr. 24 lbs. of saltpetre at £1, 6s. 10d. per cwt.; sold $\frac{1}{2}$ of it at 3d. per lb., and the other half at £1, 3s. 4d. per cwt. What sum, and how much per cent., did I gain or lose on the whole transaction?

30. A debt of £734 is to be paid, £300 two months hence, £200 six months hence, and the rest at the end of the 12 months; what is the present worth of the whole, interest at 4 per cent.?

31. Selling oysters at 3d. each I gain 5 per cent.; how much actual money and how much per cent. should I gain or lose in sell-

ing 1000 of the oysters for £1?

32. A man coming into an income of £1000 a year determines, from the day on which he first begins to receive the income, to spend only 10 of it, and to invest the remainder at the end of each year in annuities, giving £90 for each annuity of £3. What will his income be at the end of the fourth year?

33. Two brigands, A and B, robbed a traveller of £370; if A had taken £25 more, and B £25 less, A would have had \$ of what B

took. How much did each take?

34. What sum of money put out to simple interest for 4 years at

31 per cent. will amount to £259, 7s. ?

35. A grocer mixes 13 lbs. of tea at 3s. 4d. a lb. with 5 lbs. of tea at 4s. 10d. a lb.; at what price must he sell the mixture so as to gain 13d. on each lb.?

36. If the sixpenny loaf weighs 3 lbs, when wheat is at 6s, a

bushel, what ought it to weigh when wheat is at 6s. 9d. a bushel?

37. If 21 men mow 72 acres of grass in 5 days, how many must

be employed to mow 460 acres 3 roods 8 perches in 6 days?

38. What amount of profit and what percentage on the outlay would accrue from the sale of 50,000 articles purchased at \(\frac{1}{4} \)d. each, and sold at 31325 of a shilling each \(\frac{1}{4} \)

39. A sum of money amounts in 10 years at $3\frac{1}{2}$ per cent. per annum simple interest to £506, 15s. $1\frac{1}{2}$ d.; in how many years will

it amount to £703, 16s. 6 dd. ?

40. If £1 = 10 florins, 1 flor. = 10 deniers, 1 den. = 10 mils., what decimal of the English coin nearest in value would each of the above—the "florin," the "denier," and the "mil."—be respectively?

41. An acre is sometimes roughly said to be 70 yds. sq. What would the error amount to, if we adopted this statement, in calculating the area of Ireland (32,450 sq. miles)? Give answer in decimals

of sq. miles.

- 42. Three clerks, A, B, and C, in a London house are paid at the rate of 9 guineas per calendar month. A goes to New York, where he gets \$10.50 per week; B to Paris, where his pay is 7.75 francs per day; while C remains in London. Compare the yearly incomes (i.e. for 365 days) of the three, taking the dollar = 4s. 2d., and 25 francs = £1.
- 43. What is meant by "buying at so many years' purchase?" An estate is bought at 25½ years' purchase for £3400; ¾ of the purchase money remains on mortgage at 4½ per cent. per annum; the cost of repairs, &c., averages £9, 6s. &d. a year. What percentage of interest does the purchaser make on his investment?

44. A diagonal of a four-sided field is 18 chains 75 links, and the perpendiculars on it from two corners are 6 chains 54 links and 7 chains 82 links. Find its rent at 12s. per rood.

45. Find (in acres, &c.) the area of a circular ring whose inner diameter is 6 chains 25 links, and outer diameter 10 chains 35 links,

Cambridge University Examinations.

Paper 13.

PREVIOUS EXAMINATION PAPERS.

Tuesday, June 4, 1878. 9 to 111.

A.

- 1. Subtract nine hundred and sixty-seven thousand and eightynine from eight million seven hundred thousand and three; express the result in words.
- 2. What is meant by the greatest common measure of two numbers? Find the greatest common measure and the least common multiple of 4781 and 6147.
 - 3. Simplify $\frac{3}{4} + \frac{3}{8} + \frac{2\frac{3}{8}}{3 \times 3} + \frac{2\frac{3}{8}}{3 \times 3}$
- 4. Subtract $\frac{13}{18}$ of $\frac{1}{8}$ of a guinea from $\frac{2}{8}$ of $\frac{7}{16}$ of £1, and express the difference as the decimal of half-a-crown.

5. Multiply 91.77 by 091, and divide the product by 2.73.

Find the rent of 643 ac. 1 r. 27 po. of land at £1, 16s. 8d. per acre.
 How many cwt. of lead will be required to cover a roof 48 ft.

long and 32 ft. wide with a sheet of lead 12 of an inch thick? A cubic foot of lead weighs 12096 ounces.

8. A grocer has two sorts of tea which cost him 3s, and 3s, 6d, per lb. respectively; in what ratio must he mix them so as to gain 10 per cent. by selling the mixture at 3s. 8d. per lb.?

9. What is the present worth of a bill for £396, 14s. 4d. due 30

days hence at 4 per cent. per annum?

10. How much 3 per cent. stock has been sold out at 89, if the owner's income be increased by £12 a year by investing the proceeds in 4 per cent. stock at 92?

11. Find the difference between the simple and the compound

interest of £526, 4s. for 4 years at 3 per cent. per annum.

12. Income tax is at present levied on all incomes over £150, £120 being deducted from incomes under £400 before the tax is reckoned. A man observes that his tax this year, at 5d. per pound, will amount to the same as a tax at 2d. per pound upon his whole income. What is his income?

Paper 14.

B.

1. Find the difference between five million and twenty-two, and

three hundred and ninety-seven thousand and forty-nine; express the result in words.

- 2. State the rule for finding the greatest common measure of two numbers; and find the greatest common measure of 7535 and 11645. Find also the least common multiple of these numbers.
 - 3. Simplify $\frac{3}{3} + \frac{5}{5} + \frac{3}{2} \frac{2}{5}$
- 4. Subtract 1 of § of a guinea from § of § of £1, and express the difference as a decimal of a crown.

5. Multiply 619.3 by 117, and divide the product by 1.43.

- Find the rent of 526 ac. 3 r. 19 po. of land at £2, 3s. 4d. per acre.
- 7. How many cwt. of lead will be required to cover a roof 40 ft. long and 28 ft. wide with a sheet of lead $\frac{1}{10}$ of an inch thick? A cubic foot of lead weighs 12096 ounces.

8. A grocer has two sorts of tea which cost him 2s. and 2s. 6d. per lb. respectively; in what ratio must he mix them so as to gain 12 per cent, by selling the mixture at 2s. 4d, per lb.?

9. What is the present worth of a bill for £214, 13s. 4d. due 60

days hence, at 5 per cent. per annum?

10. How much 3 per cent. stock has been sold at 88, if when the proceeds are invested in 4 per cents, at 120 the owner's income be reduced by £2 a year?

11. Find the difference between the simple and the compound

interest of £635, 12s. for 4 years at 3 per cent. per annum.

12. Income tax is at present levied on all incomes over £150, £120 being deducted from incomes under £400 before the tax is reckoned. A man observes that his tax this year, at 5d. per pound, will amount to the same as a tax at 3d. per pound upon his whole income. What is his income?

Cambridge Local Examination Papers.

Paper 15.

JUNIOR STUDENTS. 1875.

TUESDAY, DEC. 14. 103 to 123.

ARITHMETIC.

[The whole working of the sums is to be sent up. Answers without the working will not count.

Answers to all questions marked A are to be fastened together in

one bundle. Answers to all questions marked B are to be fastened together in another bundle. Easy questions will be found in both

A and B.]

A 1. If the French pay off their debt at the rate of five hundred million four hundred and sixty-three thousand two hundred and fifty francs a year, how much will they have paid in thirteen years? If this is at the rate of fourteen francs a year for each person, what is the population?

(Write the answers in words as well as in figures.)

À 2. An innkeeper buys 10 gallons of spirits at 12s. per gallon, 15 at 4s. 6d., and 18 at 5s. 9d. How must he sell the mixture per gallon that he may gain £2, 2s. 3d. on his outlay?

A 3. Simplify the expression

$$\frac{\frac{1}{2} + \frac{1}{3} + \frac{1}{4}}{\frac{2}{5} + \frac{2}{7} + \frac{2}{9}}$$

and reduce to its simplest form

$$3_{\frac{1}{125}}$$
 of $3\frac{4}{7}$ ÷ $\left(\frac{47}{345}$ of 9).

A 4. Find the value of 775625 of £5, and reduce 2 qrs. 21 lbs. to the decimal of a ton.

A 5. A body of 50,000 soldiers is to be raised in 4 provinces which contain respectively 175002, 82434, 22116, and 20448 men fit for

service. Find the number which each must supply.

A 6. Define the terms interest, discount, present worth. Find the simple interest on £281, 12s. at $3\frac{1}{8}$ per cent. per annum for 4 years

and 2 months.

A 7. If 15 horses and 148 sheep can be kept for 9 days for £75, 15s., what sum will keep 10 horses and 132 sheep for 8 days, supposing 5 horses eat as much as 84 sheep?

B 1. A silver tankard weighs 41 ozs. troy. What is its avoirdupois weight, assuming that the pound avoirdupois contains 7000 grains

troy?

B 2. Find by practice the cost of 27 cwt. 3 qrs. 6 lbs. of metal at £22, 8s. per cwt.

B 3. State the rule for the multiplication and division of decimals. Divide 12.6 by .0012 and .065341 by .00475.

B 4. A goods train is 8 miles ahead of an express which travels at the rate of a mile in 11 minutes. It is run into in 20 minutes. How many miles an hour was the goods train running?

B 5. By selling a carriage for £73, 3s. I should lose 5 per cent.

At what price must I sell it to gain 15 per cent.?

B 6. Which is the better investment, French 3 per cent. at 641, or United States 5 per cent. at 1021? Calculate the difference of

income produced by an investment of £1000 in each.

B 7. A rectangular court is 120 ft. long and 90 broad, and a path of the uniform width of 10 ft. runs round it. Find the cost of covering the path with flag-stones at 4s. 6d. per sq. yd., and the remainder of the court with turf at 6s. 6d, per 100 sq. feet.

Paper 16.

SENIOR STUDENTS. 1875.

Tuesday, Dec. 14, 1875. 10# to 12#.

1. Multiply six hundred and eight thousand eight hundred and seventy-two by sixty-nine, and divide the product by ninety-two.

2. A man laid out £12, 18s. 8d. in gloves at 2s. 8d. the pair: some of them faded and were unsaleable: the rest he sold for £14, 13s. 10d. at 3s. 5d. the pair. How many pairs faded?

3. What is the price of a silver bowl weighing 5 lbs. 8 oz. 9 dwt.

at 5s. 10d. per oz. ?

4. Reduce $\frac{4844}{5536}$ and $\frac{7623}{8316}$ to their lowest terms, and then divide their sum by 139.

5. Convert 3 064814 into a vulgar fraction in its lowest terms,

and divide 5.5811 by .067.

6. Express $\frac{13}{29}$ of $\frac{8}{39}$ of 9 days 16 hrs. + 0390625 of 10 days 16

hrs. as the decimal of 231 days.
7. A man bought 240 cows at Rotterdam, paying £14, 6s. for each; their carriage to London cost 1/2 of his outlay; he then exchanged them for 299 ponies which he sold for £15 per head. What did he gain per cent. on his expenditure?

8. If 4 men earn as much in a day as 7 women, and 1 woman as much as 2 boys, and if 6 men, 10 women, and 14 boys working together for 8 days earn £22, what will be the earnings of 8 men

and 6 women working together for 10 days?

9. A debt of £65 is paid in francs valued at 9 d. each, at a time when 25 francs are worth £1. What does the creditor gain or lose?

10. Find the discount on a bill for £397, 2s. due half a year

hence, at 5 per cent. per annum.

11. A person travelled from London to Loch Lomond (480 miles) by sea, rail, and coach. The distance by coach was \(\frac{1}{3} \) that by rail, and the distance by rail \(\frac{2}{30} \) that by sea: the cost of the journey by coach was \frac{2}{3} that by rail; the cost by rail was \frac{3}{10} that by sea.

much did the whole journey cost, coach fare being 4d. per mile?

12. A person has a certain capital, half of which he invests in the 3 per cents. at 90, and the other half in the 5 per cents. at 110. What was his capital, if his total income (from both sources) is £6883, 10s. ?

Paper 17.

JUNIOR STUDENTS. 1880.

A 1. Add together two million three hundred thousand and forty pence, eight hundred and eight thousand sixpences, and ten million one hundred and thirty-five thousand nine hundred and fifty shillings. Express the answer in pounds.

A 2. Multiply 29 cwt. 16 lb. by 24, and divide 944 cub. yd.

1 cub. ft. 1104 cub. in. by 59.

A 3. A man buys 497 sacks of potatoes for £339, 1s. 112d., and sells 248 sacks for 17s. 9dd. per sack; the remainder he sells for 18s. 21d. per sack. Find his total gain.

A 4. Find the value of 100,000 rupees in france, I rupee being

reckoned as worth 1s. 101d. and 25 francs as worth £1.

A 5. Find by practice the cost of 16 oz. 6 dwt. 20 gr. of gold at £3, 17s. 6d. per oz.

A 6. Reduce to a fraction in its lowest terms—

1 + 2 + 2 + 1 + 1 + 1 + 1

Divide \(\frac{2}{3} \) of $4\frac{1}{2}$ by $\frac{4}{13}$ of $3\frac{1}{4}$, and 12.9729 by 312.6.

A 7. Add together $\frac{1}{2}$ of a guinea, $\frac{3}{2}$ of a sovereign, $\frac{7}{20}$ of a crown, and $\frac{1}{2}$ of a shilling. Express the result as the fraction of $4\frac{7}{20}$ of £1.

B 1. Reduce 2 ft. 6 in. to the decimal of a yard, and find the

number of pence in 025 of £1.

B 2. A sum of £50,000 for drainage purposes has to be raised by a rate from four townships, A, B, C, and D. A is rated at £175,002, B is rated at £82,434, C is rated at £22,116, and D is rated at £20,448. How much in the pound must the rate be, and how much must each contribute?

B 3. Distinguish between interest and discount.

Find the discount on £929, 10s. due $2\frac{1}{2}$ years hence at $2\frac{1}{2}$ per cent. simple interest.

B 4. £3600 of 3½ per cent. stock is purchased for £3519. What is the price of the stock, and what income would be thence derived?

B 5. The area of a rectangular field contains 975,744 sq. ft.; one of the sides is 3\frac{1}{2} times as long as the other. What is the length of each side?

Paper 18.

SENIOR STUDENTS. 1880.

 Find the quotient and remainder arising from the division of 359907 by 789.

If in dividing a number by 336, the operation be performed by short division by employing the factors 6, 7, 8 in succession, and the several remainders be 1, 2, 3, what is the complete remainder?

2. If a person's income for the year 1880 be £37, 15s. per calendar month, and he spend at the rate of £1, 4s. $7\frac{1}{2}$ d. per day, how much will he have left at the end of the year?

3. If 44 yd. 1 ft. 9 in. of cloth cost £42, 7s. 9d., what will be the

cost of 74 yd. 11 in.?

4. Simplify 237655

(i.)
$$\frac{237655}{367285}$$
 (ii.) $\frac{\frac{1}{2} + \frac{1}{4} + \frac{1}{7} + \frac{1}{12} + \frac{1}{21}}{\frac{1}{2} + \frac{2}{4} + \frac{2}{7} + \frac{1}{12} + \frac{2}{21}}$

Reduce 22 days 4 hr. 35 min. 42 sec. to the fraction of 34 days 20 hr. 56 min. 6 sec.

5. Divide

(i.) 121.9192 by 3.04;

(ii.) 12·19192 by 30·4.

Find the value of 07890625 of a ton, and simplify

$$1\frac{2}{3}$$
 of $\frac{.53}{.61}$ of $\frac{.825}{.416}$

6. Find by practice the cost of

(i.) 4112 things at £1, 1s. 7½d. each.

(ii.) 3 ac. 1 r. 3 po. 19½ sq. yd. at £110 per ac.
 7. The breadth of a room is half as much again as its height; its

length is twice its height; it costs £5, 5s. to paint its walls at 14d. per square foot; what are its dimensions?

8. Three men can do as much work as 5 boys; the wages of 3 boys

8. Three men can do as much work as 5 boys; the wages of 3 boys are equal to those of 2 men. A work on which 40 boys and 15 men are employed takes 8 weeks, and costs £350. How long would it take if 20 boys and 20 men were employed, and how much would it cost?

9. A walks to a place at the rate of $4\frac{1}{2}$ miles per hour; at 8 miles from his destination he meets B, and turns back with him (walking at B's rate) for a mile; if A is half an hour late at his destination, what is B's rate, and at what rate should A have walked after parting with B so as to arrive at the proper time?

10. If the difference between the interest and discount of a sum

of money for 2 months at 41 per cent. be 2s. 3d., find the sum.

11. If the price of 3 per cent. stock be 96, a person can obtain an annual income of £1 more than he can if the price be 97. How much has he to invest?

12. In an election A receives promises from half the constituency, B from 18; 400 voters, however, had promised both candidates, of whom 300 vote eventually for B and 100 for A. The electors who had not promised either do not vote. B wins by 80 votes. What were the numbers for each?

Oxford Local Examination Papers.

Paper 19.

JUNIOR CANDIDATES. 1875.

TUESDAY, MAY 25, from 9 to 11 A.M.

I. 5. ARITHMETIC.

[N.B.—Every candidate is required to satisfy the examiners in this paper. Attention should be paid to spelling and handwriting. No credit will be given for any answer, the full working of which

is not shown.]

1. Multiply one hundred million one hundred thousand and ten by five thousand and five; and divide five hundred and one million five hundred by three thousand eight hundred and fifty.

2. Goods were bought for £560, 15s. 6d.; there was further paid

for packing £1, 10s.; for carriage £12, 6s. 8½d.; and for import duty £3, 8s. 6½d. The goods were then sold for £655, 8s. 5d. What was the profit on the transaction?

3. The profits of a business, amounting to £904, 11s. 4d., are divided equally among the partners. If each receives £56, 10s. 8dd.,

what is the number of the partners?

4. How many grains of gold are there in a cup weighing 8 oz. 4 dwts.?

5. What is a quarter's rent of 350 acres of land, if £11, 5s. 9d. per annum be given for 9 acres?

6. What is the value of 13 cwts. 3 qrs. 4 lbs. at £2, 18s. 4d. per cwt. ?

7. Add together $\frac{1}{8}$ of a guinea, $\frac{8}{8}$ of a pound, and $\frac{7}{8}$ of a shilling; and reduce a farthing to the fraction of a guinea.

8. What length of time is represented by 58 of a year?

9. A coach travels 71 miles an hour; how far will it have gone between 10.15 A.M. and 5.45 P.M.?

Paper 20.

WEDNESDAY, MAY 26, from 9 to 11 A.M.

MATHEMATICS.

[N.B.—No credit will be given for any answer, the full working of which is not shown.]

1. Simplify $\frac{6}{7} + \frac{7\frac{3}{4} - 6\frac{1}{3}}{2\frac{1}{4} \times 9}$; and divide 33 yds. 0 ft. 8 in. by 13).

2. Divide '0096 by 1.2; and express 7s. 2d. as the decimal of £3, 15s. 9d.

3. If a family of 7 persons can live on £140 for 28 weeks, how long can a family of 9 persons live on £135?

4. Find the simple interest upon £41, 13s. 4d. for 8 months at 4½ per cent. per annum.

Paper 21.

SENIOR CANDIDATES. 1875.

TUESDAY, MAY 25, from 9 to 11 A.M.

[N.B.—Every candidate is required to satisfy the examiners in this paper. Attention should be paid to spelling and handwriting. No credit will be given for any answer, the full working of which is not shown.]

1. Find the greatest common measure of 5,568,981, and 506,382; and the least common multiple of 32, 48, 40, 14.

2. Simplify $\frac{\frac{1\frac{2}{3} \text{ of } 1\frac{1}{4}}{3\frac{2}{6} + \frac{5}{1\frac{1}{4}}} + \frac{4}{5 + \frac{6}{7 + \frac{2}{3}}}$.

3. Give a rule for the division of decimals, and divide 12.5 by 0025, and 4.26 by 73, expressing the latter result as a decimal.

4. Find what length of paper 14 ins. wide will cover the walls of a room 15 ft. long, 13 ft. broad, and 10 ft. high; and find the cost if the paper is sold at 1½d. per foot.

5. Find the square roots of 11854249 and 1.7.

6. A merchant buys a fifty gallon cask of wine for £62, 10s., and sells it at 26s. per gallon; what is his gain per cent.?

7. If the wages of 4 men for 12 days be £6, what would be the

wages of 6 men for 10 days?

8. How much 3½ per cent. stock at 97½ can be purchased for £3519, and what income would be thence derived?

Paper 22.

JUNIORS. 1877.

TUESDAY, MAY 29, from 9 to 11 A.M.

- 1. Express the number 2300025015 in words; and write in figures the sum of ninety thousand nine hundred and nine millions and
- 2. If out of £52 I pay away £25, 16s. 12d., £2, 17s. 11dd., £9, 5s. 34d., and 7s. 74d.; how much shall I have left?
 3. Divide £34,161, 17s. 11d. by 2705.

- 4. A truck is loaded with 120 sacks, each sack weighs 7 lbs. 10 oz. and contains 84 lbs. of grain; what is the weight of the load in tons, cwts. qrs. lbs.?
- 5. Add together $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{4}$; from $1\frac{1}{4}$ of $4\frac{1}{8}$ subtract $2\frac{1}{12}$ of $2\frac{1}{16}$.

 6. Reduce $\frac{1}{12}$ $\frac{1}{8}$, $\frac{1}{24}$ to decimals; also 15625, 0026 to vulgar fractions.

7. Divide 17.5 by .125, by 5, and by 25000.

8. When an income of £1150 is reduced by taxation to £1063, 15s., what is the income of a person who has £518 left after deducting the taxes?

Paper 23.

JUNIORS. MATHEMATICS.

1. Simplify
$$\frac{1}{2-\frac{3}{4-\frac{5}{6}}} - \frac{1}{2+\frac{3}{4+\frac{5}{6}}} \times 10\frac{5}{6}$$
.

2. If 5 men dig a trench in 1\frac{1}{3} days working 4\frac{1}{2} hours a day, how long would 1 man take to dig a trench half as large again working 5 hours a day?

3. How often is 125 of £1 contained in 17.5 of 1s.?

4. I hold £10,000 of stock in the 3 per cents.; I sell out at 941 and invest the purchase money in 4 per cent. railway debentures at 105; what change do I make in my income?

Paper 24.

SENIORS.

TUESDAY, MAY 29, from 9 to 11 A.M.

[N.B.—Every candidate is required to satisfy the examiners in this paper. Attention should be paid to spelling and handwriting. No credit will be given for any answer, the full working of which is not shown.]

1. Simplify $1\frac{1}{11} - \frac{1 - \frac{7}{22}}{2 - \frac{1}{3}} + \frac{1\frac{2}{3}}{3\frac{1}{2}} - \frac{5\frac{5}{6}}{6\frac{1}{4}}$ of $\left(\frac{1}{6} - \frac{\frac{1}{3} - \frac{1}{3}}{4\frac{1}{4} - 3\frac{1}{6}}\right)$.

2. Find the least common multiple of 125, 136, 180, 24, and 27;

and the greatest common measure of 23,760 and 26,136.

3. A postman whose pay for a week is 15s. is fined 1s. 6d. if he comes in late, and at the end of 13 weeks he receives £8, 15s. 6d.; how often was he late?

4. Divide 1028.5 by .0017, and .775 of £5 by .01024 of 1s. 111d.

5. Find the square root of (1) 998001;

(2) $27\frac{54}{361}$.

6. I sell £43,400 stock out of the three per cents. at 96, and I buy six per cent, debenture stock at 105; find the difference in my annual income.

7. If 15 men build a wall 25 yd. long 2 yd. high 2 ft. thick in 14 days, in what time will 7 men build a wall 30 yd. long 7 ft. high and 1 ft. thick?

8. What sum put out to interest for $7\frac{1}{2}$ years at 5 per cent. simple interest will amount to £124, 13s. 4d.?

Paper 25.

JUNIORS. 1878.

TUESDAY, MAY 28, from 9 to 11 A.M.

1. Divide two million four hundred and ninety thousand two hundred and one by four thousand and eighty-nine.

2. Multiply twenty-nine pounds nineteen shillings and tenpence

three-farthings by one hundred and ninety-two.

3. Thirty-three telegraph posts, placed at equal distances, extend a mile; how far apart are the posts?

4. Divide 198 acres 3 roods 16 perches 3 yards 72 inches by 187.

5. Find the cost of a ton of sugar at \(\frac{1}{2} \text{d.} \) per lb., of an ounce of tea at 5s. 8d. per lb., and of a peck of flour at \(\frac{1}{2} \text{3} \) per quarter.

6. If 3 men do a piece of work in 60 days, how many will do it

in 20 days?

If 159 articles cost 19s. 10½d., find the cost of 161 such articles.
 Add together 1½, 25, 31, 43.
 Also multiply together 44, 22,

31, and divide the product by 12.

9. Divide '72 by 1.8, by 18, and by '018. Also express half-acrown as the decimal fraction of a pound, and find the value of '00009765625 of a ton.

Paper 26.

JUNIORS. 1878.

MATHEMATICS.

1. If 25.4 francs be equivalent to £1 sterling, find the value in English money of 511.175 francs.

2. Find by practice the rent of 30 ac. 3 r. 26 po. at £2, 13s. 4d.

per acre.

- 3. Divide £180 among A, B, and C, so that A may receive three times as much as B, and B and C together may receive half as much as A.
- 4. Find the compound interest and amount of £4800 for 2 years at 4 per cent.

Paper 27.

SENIORS. 1878.

TUESDAY, MAY 28, from 9 to 11 A.M.

[N.B.—Every candidate is required to satisfy the examiners in this paper. Attention should be paid to spelling and handwriting. No credit will be given for any answer, the full working of which

is not shown.]

1. Simplify $\frac{1\frac{1}{2}}{4\frac{1}{4}} + \frac{3\frac{1}{3}}{4\frac{1}{6}} - \frac{2\frac{5}{6}}{4\frac{5}{6}} + \frac{3}{26}$ of $5\frac{1}{4}$.

2. Find the difference between § of £1, 13s. 9d. and § of £5, 18s. 5d., and reduce the result to the fraction of a guinea.

3. Find the least common multiple of 48, 27, 81, 165, and 110;

and the greatest common measure of 6023 and 15466.

4. Make out a bill for the following articles:—17 yards of silk, at 11s. 7 d. a yard; 648 buttons, at 1s. 9 d. a gross; 15 yards of velvet, at 1s. 114d. a yard; and 153 reels of cotton, at 11d. a dozen.

5. A person selling apples at 3 for a penny gains 5 per cent.;

find the gain or loss per cent. when 25 are sold for sixpence.

6. Find the number of men required to mow 114 acres in 9 days,

if 14 men can mow 76 acres in 6 days. 7. Reduce £3, 17s. 6d. and £14, 10s. $7\frac{1}{2}$ d. each to the decimal of

£1, and divide the second result by the first.

8. I invest £7560 in the 3 per cents. at 94½, and when the funds fall to 90 I sell out a quarter of my stock; afterwards, when the funds are at 943, the remainder of the stock is sold; what is the alteration in my capital?

Paper 28.

Tuesday, May 27, from 9 to 11 a.m. 1879.

ARITHMETIC.

- 1. Multiply one hundred and ninety-eight million seventeen thousand and six by four thousand and eighty-five.
 - 2. Reduce 574 pints to bushels, pecks, gallons, and quarts.

3. Divide £11,705, 12s. 6d. by 100.

4. A farmer pays 30s. an acre rent on a farm of 215 acres. working expenses amount to £589, 17s. 44d. His receipts are £1305, 6s. 8d. Find his net income.

5. Multiply together 32, 32, 11, 13; and reduce 9s. 4d. to the

fraction of 7s. 7d.

6. Reduce to vulgar fractions 072 and 1.483. Divide 07 by 14 and by '014.

7. If a carrier pigeon flies 17 miles in 15 minutes, how long will it take to fly 14 miles?

8. If a ship sail 110 miles in 11 hours, how many feet does it pass through in a minute? 9. Find the cost of 3 tons 2 cwt. 6 lbs. of sugar at 21d. per lb.

Paper 29.

JUNIORS. 1879.

MATHEMATICS.

1. Find the cost of carpeting a room 20 ft. 3. in. long and 13 ft.

6 in. broad at 5s. 4d. per square yard.

2. The circumferences of 2 wheels of a locomotive are 5 and 6 yds. respectively. If the smaller make 704 revolutions in a given time, when the engine travels at the rate of 40 miles an hour, how many revolutions will the larger make in the same time, when the engine travels at the rate of 60 miles an hour?

3. A grocer mixes 72 lbs. of tea at 2s. 10 d. per lb. with 90 lbs. of tea at 2s. 6d. per lb.; at what price per lb. must he sell the

mixture so as to gain 5d. per lb.?

4. Find the difference between the simple and the compound interest on £2718, 15s. for 2 years at 3 per cent.

Paper 30.

SENIORS.

TUESDAY, MAY 27, from 9 to 11 A.M.

[N.B.—Every candidate is required to satisfy the examiners in this paper. Attention should be paid to spelling and handwriting. No credit will be given for any answer, the full working of which

is not shown.]

- 1. Find the cost of 213 articles at £1, 17s. 21d. each, and of 17 cwt. 1 qr. 12 lbs. at £1, 19s. 8d. per cwt.
 - 2. Simplify (1) $\frac{2592}{3456}$, (2) $\frac{23}{23} \frac{11}{2} + \frac{23}{21}$ of 9 3. Find the value of $1\frac{21}{231}$ of £2, 19s. 9d.

4. Divide 64 by 016, and multiply 6.76 by 05.

- 5. Find the value of 03571428 of a guinea; and of 9 pole + 241 yard + .87 foot + .684 inch.
- 6. After paying 1 of my money to one person, 1 to another, and to a third, I had 1 d. remaining. How much had I at first? 7. A person walks at the rate of 31 miles an hour. Three hours

after he is followed by another person walking at the rate of 5 miles an hour. In what time will the latter overtake the former?

8. If a horse be sold for £90 at a gain of 20 per cent., what was

the cost price of the horse?

9. If 4 lbs. of bread cost 5 d. when wheat is £2, 4s. per qr., what is the cost of 6 lbs. of bread when wheat is £2, 8s. per qr.?

Paper 31.

JUNIOR STUDENTS. 1880.

TUESDAY, MAY 25, from 9 to 11 A.M.

[N.B.—Every candidate is required to satisfy the examiners in the first part of this paper. Attention should be paid to spelling and handwriting.

No credit will be given for any answer, the full working of which

is not shown.]

1. Write nine hundred and nine million ninety-nine thousand

in figures, and 1010010001 in words.

- 2. A tank contains 11987 gallons of water. How many casks holding 29 gallons each can be filled from it, and how many gallons will be left in it when they are full?
- 3. Multiply £237, 4s. 9d. by 111; and divide 75 miles 1 fur. 39 po. 3 yd. by 75.

4. Reduce 13 tons 6 cwt. 3 qr. 24 lb. 10 oz. 7 dr. to drams.

- 5. Add together 4, 64, and 4 of 61; and express 3 quarts 1 pint as the fraction of 3 bushels 1 peck.
- 6. Divide '0003 by '000005; multiply '016 by '3; and find the value of '00025 of £100.

7. If 54 horses cost £3600, how much will 42 cost?

- 8. If a field containing 5 acres 1 rood produced 28 quarters of wheat, what is the area of a field which produces 100 quarters?
- [N.B.—The following questions are intended for those candidates only who offer Mathematics as a subject, and are not to be attempted by any until they have done all they can do of the first part of this paper.]
- 9. How many bricks, each 9 in. by 4½ in. by 3 in., are there in a stack 36 ft. long, 9 ft. wide, and 12 ft. high?

10. Two elephants and four horses can do a piece of work in 7\frac{1}{2} hours, and a single elephant can do it all in 20 hours. How long will a single horse take in doing it?

11. Divide the number 702 into three parts proportional to 2,

3, and 4.

Also divide the same number into three parts proportional to $\frac{1}{2}$,

and \(\frac{1}{2} \).
 12. Find in what time the simple interest on £375, at 4 per cent.
 per annum, will amount to £91, 5s.

Paper 32.

SENIOR STUDENTS.

TUESDAY, MAY 25, from 9 to 11 A.M.

[N.B.—Every candidate is required to satisfy the examiners in this paper. Attention should be paid to spelling and handwriting.

No credit will be given for any answer, the full working of which

is not shown.]

1. Write out the tables of long and square measure; and multiply

4 ac. 1 r. 27 po. 19 yd. 4 ft. 72 in. by 27.

2. If 6 dozen tablespoons weigh 11 lb. 6 oz. 12 dwt., and the same number of teaspoons weigh 3 lb. 7 oz. 10 dwt., what is the difference in weight between a tablespoon and a teaspoon?

3. An order for books to the value of £35, 15s. 4d. is subject to a reduction of 1s. 3d. in the pound. What is the net sum to be

paid?

4. Simplify (1) $\frac{1160}{1624}$, and (2) 5 times $12\frac{3}{4} \div 2\frac{1}{16}$.

Divide £219, 9s. 7d. by 123.

- Reduce 11 to a decimal, and 015625 to a vulgar fraction. Divide 1 44 by 2 5; and 1440 by 025.
- 6. Find the value of

$3\frac{19}{960}$ of £1 + 1.16 of 10s, 6d.

7. Reduce 2 lb. 3 oz. 5 dwt. 6 gr. to the decimal of 3 lb. troy.

8. Extract the square root of 11883 1801, and find the cube of the number whose square is 256.

9. Find the simple interest upon £1684, 3s. 4d. in 2½ years at 4½

per cent.

10. If 7 cwt. 3 qr. 22 lb. of potatoes cost £4, 3s. 5½d., what is the cost of half-a-ton?

11. Twelve men are engaged to do a piece of work which they

would complete by working 8 hours a day for 14 days; and when half the work is done eight of the men leave. In what number of days will the rest be able to complete it, if they work 10½ hours each day?

From Civil Service Examination Papers.

Paper 33.

1. A rectangular grass plot, the sides of which are as 2:3, costs £14, 8s. for turing; at the rate of 4d. per sq. yd., find the lengths of its sides.

2. A and B buy cigars at £2, 1s. 8d. per hundred. A sells them at sixpence each, while B sells them in bundles of 25 for 12s. Compare their gains per cent.

3. At what time between 12 and 1 o'clock are the hands of a clock

exactly opposite each other?

4. Å man estimates his expenses as follows: Rent of house onetenth of income; expenses of living 80 per cent. of remainder. He finds he then will save £126 per annum. What was his total income?

5. Two pumps discharging respectively 80 and 100 gallons per minute are employed to drain a well. It is observed that if the smaller pump only is at work the water sinks one inch per minute, and if both are employed from the first, the well is pumped dry in two hours; find its depth.

6. The mean temperature from the 9th to the 15th January 1877, both inclusive, was 36.6°, and from the 10th to the 16th it was 39.9°; the mean temperature on the 9th was 30.5°; what was it on the

16th ?

- 7. Find the value of .65 of .411 of $\frac{33}{13}$ of 2.432 of 13s. 6d.
- 8. Find exactly the square root of $8636\frac{136}{225}$, and the cube root of 000017576.
- 9. The dimensions of a rectangular box are as 2:3:4; and the difference between the cost of covering it with sheet lead at 8d. and at 8dd. per square foot is 4s. 10dd. What are the dimensions of the box?
- 10. Reduce to the decimal of a cubic yard the volume which is expressed in the duodenary scale by 1538 cubic inches.

11. A merchant buys wine at £47, 5s, per hogshead, and offers it for sale at 40s, per dozen bottles. If he allows 5 per cent. discount for cash payment, what profit per cent. will he still make on his outlay?

12. Two men run a three-mile race round a course of $\frac{\pi}{10}$ mile. If their rates are as 4:3, how often and where does the winner pass

the other?

13. Of the inhabitants of a district devastated by war, 60 per cent, were slain, § of the remainder perished in flight, and 200 alone survive. What was the population of the district?

14. Find the value on March 1st of the expectation of a sum of £3724, 10s, 5d. due November 30th the same year, the rate of

interest being 5 per cent. per annum.

15. What income will be obtained by investing £2849 in 3 per cent. stock at 921? What sum invested would produce the same income when the price of the stock is 91?

16. Find the area of a quadrilateral figure in which one of the diagonals is 90 feet, and the perpendiculars upon it from the opposite

angles are 60.5 feet and 36.7 feet respectively?

17. What quantity of metal will be required to make a hollow spherical ball, the external diameter being 18 inches, and the thickness $4\frac{1}{2}$ inches?

18. Find the area of the surface of a frustum of a cone, the diameters of the ends being 2 ft. 6 in. and 1 ft. 3 in., and the height

5 ft.

19. In Fahrenheit's thermometer the freezing point is marked 32° and the boiling point 212°, and in the Centigrade thermometer the freezing point is 0° and the boiling point 100°. When the temperature according to Fahrenheit is 65°, what is it by the Centigrade?

20. The pressure of compressed air varies inversely as its volume. If the pressure on the inner surface of a cylinder, fitted with a piston, be 20 lb. on the square inch, and when the piston is forced in 2 inches, the pressure becomes 30 lb. on the square inch, what is the length of the cylinder?

21. Find the cube root of 8.615125, and the square root of

 $1879\frac{165}{196}$

22. Find the value of $2\frac{1}{3}$ of $\frac{4\frac{1}{3}}{3\frac{1}{3}}$ of 1.209 of £5, 10s., and reduce the result to the fraction of 3 63 of £16, 3s.

23. Multiply together 1 ft. 10½ in., 3 ft. 10 in., and 5 ft. 0¾ in.;

and express the result as a decimal of a cubic yard.

24. The width of a room is $\frac{3}{2}$ of its length; and it costs £11, 9s. 8\frac{1}{2}d. to carpet the floor at 4s. 6d. per square yard; and £1, 12s. 9\frac{3}{2}d. to

paper the walls, at 3d. per square yard. What is the height of the room?

25. Express in the duodenary scale of notation, in square feet, and duodecimals of a square foot, the area which is expressed in the denary scale by 42,050 square inches.

26. If 5½ per cent would be gained by selling certain goods at £36, 18s. 6d. per cwt., what is the gain per cent. when they are

retailed at 7s. per lb.?

27. A can walk 3 miles whilst B walks 5, and C can walk 6 whilst A walks 3. What start can C give B in a walking race of 3 miles?

28. The rate of exchange between London and Paris being £1 = 25 25 francs, how much per cent. is gained by taking English sovereigns at 25 francs each? And how much per cent. is lost by parting with them at that price?

29. If £63, 8s. is reckoned to be the exact present value of £67, 7s. 3d., due 15 months hence, at what rate of interest is the

discount calculated?

30. A person, having £996, 5s. stock in 4 per cent., sells at 105; out of the proceeds he purchases £1000 stock, paying 3 per cent. per annum, at 92½; and lends the remainder at 5 per cent. per annum. What is the alteration in his income?

31. The hypotenuse of a right-angled triangle is 6.5 feet, and one side is 5.2 feet. Find the area of the triangle, and the ratio of the parts into which it is divided by the perpendicular from the right

angle upon the hypotenuse.

32. Compare the weight of a solid brick, of which the dimensions are 9 in., 4½ in., and 2½ in., with that of a brick of the same dimensions and same material, but perforated perpendicularly to the largest faces in eight places, the perforations being circular and of ‡ in. diameter.

33. Find the number of square feet in the surface of a buoy, in the form of a cone and hemisphere united by the rim of their common base, the height of the cone and diameter of the base being each 8 ft.

34. The expansion of a gas, under constant pressure, is 003665 of its volume for each degree of increase in temperature. What is the volume which will be expanded into 5½ cubic inches when the temperature is raised 3°?

35. A tank, containing 36 gallons of water, has two pipes, through one of which 10 gallons will flow in in 6 minutes, and through the other 10 gallons will flow out in 3 minutes. If both pipes be opened together the water sinks 3 inches in 2 minutes. What is the depth of water in the tank?

36. Find the amount of £4750 in 3 years at 5 per cent. per annum, compound interest, neglecting fractions of a penny.

37. Extract the square root of 560.1; and the cube root of 4.173281.

38. The net rental of an estate, after deducting 7d. in the pound for income-tax, and 5 per cent. on the remainder for the expenses of collecting, is £1918, 7s. 4d.; find the gross rental.

39. Find the decimal of a shilling which differs from one penny

by the millionth part of a shilling.

40. If the price of coal be 42s, per ton, and if the value of coal be to that of coke as 5 to 4, calculate the price of 10 chaldrons of coke, 3 chaldrons being equal to 2 loads, and each load weighing 21 cwt.

41. What is the exact time when the hour and minute hands of a

watch coincide between 7 and 8 o'clock?

42. Find the value of $\frac{2}{3\frac{1}{2}}$ of $\frac{4}{\frac{7}{7}-\frac{1}{3}}$ of 0375 of 8 of £2, 7s. 6d.

43. A room is 18 feet high, 35 feet 9 inches long, and 19 feet 3 inches wide. How many yards of paper 30 inches wide will it take to paper the room, and what will be the total cost, the price of the paper being 1½d. per yard?

44. A grocer buys 14 lbs. of chicory for 4s. 8d. and mixes it with 56 lbs. of coffee, which cost him 1s. 2d. per lb. What will he gain

per cent. by selling the mixture at 1s. 3d. per lb.?

45. Find the square root of 6.5536, and the cube root of 5735339.

46. Resolve the numbers 30240, 235690, and 121500 into their prime factors, and thence find their least common multiple.

47. Find the square root of 413 7156, and the cube root of 54872.

48. Find the value of $3\frac{3}{4}$ of $\frac{2\frac{1}{4} + 3\frac{1}{2}}{9\frac{1}{8} - \frac{1}{2}}$ of $02\overset{\circ}{7}$ of £3, 12s.

49. A and B run a race of 4 miles. A starts 3 minutes before B, and runs at the rate of a mile in 5 minutes. B runs at the rate of

a mile in 4 minutes. Which wins, and by what distance?

- 50. If a second-class passenger can travel 3 miles for the same fare as a first-class passenger can travel 2, and the second-class fare for 154 miles is 22s., how far can a first-class passenger travel for £2, 2s.?
 - 51. Find the square root of $516\frac{348}{361}$, and the cube root of 474:552.
 - 52. Find the value of $339 \times 2\frac{16}{17} \div 648$.

53. If I invest £3591 in 3 per cent. consols at 85½, what income shall I derive from them, and what interest per cent. shall I get on the money invested?

54. A runs a 2-mile race with B and loses. Had he run a third quicker he would have won by 22 yards. Compare the rate at which

ach ran.

55. Find the square root of 103041 and of 4281 0849.

56. Find the value of $\frac{3}{8}$ of $\frac{73}{86}$ of $1\frac{7}{8} + \frac{1}{26}$ of 0125 of £76, 1a. 4d.

57. A, B, C, and D can together do a piece of work in 5 hours. A would take 16 hours, B 15 hours, and C 20 hours to do the same alone. How long would D take to do it alone?

58. Three persons, A, B, and C, purchased a ship, of which A paid for 2, B for 3, and C paid £400; what part of the ship had C, and

what did A and B pay?

59. How many cubic feet of brickwork are there in a wall, measuring 427 feet 6 inches long, 13 feet 4 inches high, and 1 foot 2 inches wide?

60. If the cost of 1737 gallons of Geneva in bond were 3s. 9d. per gallon, at what price per gallon duty paid must it be sold to pay the importer a profit of 121 per cent., the duty being calculated at

10s. 5d. per gallon?

61. If 2432 gallens of wine costing 4s. 7d. per gallon were blended with 4976 gallons of wine worth 1s. 5d. per gallon, both liable to the duty of 2s. 6d. per gallon, what would be the cost per dozen reputed quarts duty paid, including 2s. 2d. a dozen for the expense of bottling?

62. If 273 chests Assam tea, weighing 93 lbs. each and worth in bond 1s. 5d. per lb., were bulked with 562 chests of China tea, each weighing 97 lbs. and worth 9d. per lb. in bond, what would be the average cost per lb. in bond, and what would be the cost of the whole duty paid, after deducting a discount of 2½ per cent. ?

63. From £4,176,295, 13s. 7d. subtract £3,795,148, 16s. 10d., and show the interest upon the balance at 31 per cent. for 15 months.

64. Find the value of 012 of 396 of 16.65.

65. Extract the cube root of 51478848.

66. A person can discharge a debt by paying at the end of one, two, and three years, equal instalments of £1771; what is the amount of the debt, interest being reckoned at 5 per cent.

67. If the alloy in a shilling be 18 of its mass, and the coin be worth

d. if all alloy, what would be its exact value if it were all pure silver?

68. Spirit is composed of 5.295 alcohol and 4.027 water. What is the weight of each in a lb. of the mixture? and what is the weight of a mixture containing a lb. of water?

69. Calculate, by practice, the drawback on 51 barrels, 3 firkins,

4 gallons at 7s. 9d. per barrel.

70. Find the average strength of 230.7 gallons at 5.5 o.p., 119.2 at proof, and 90 at 24 u.p., and how much water will be required to reduce it to 61.4 u.p.?

71. Wine containing 17½ per cent. of spirit is frozen, and the ice is removed. The strength is then 22.5 per cent. What quantity of water, in the shape of ice, was removed from 504 gallons of wine?

72. From the sum of $\frac{1}{6}$, $\frac{1}{6}$, $\frac{1}{6}$, $\frac{1}{6}$, deduct the sum of $\frac{1}{6}$, $\frac{1}{6}$, and $\frac{1}{6}$, and reduce the fraction to its lowest terms.

73. Divide £35 amongst 4 persons in the proportions of $\frac{1}{2}$, $\frac{2}{3}$, $\frac{4}{3}$,

and #.

74. Reduce 01747 to a vulgar fraction, and divide it by 11 of 2.
75. What fraction of a guinea is equal to the difference between 3 of a crown and 13 of a shilling?

76. The 5 per cent. on a quantity of malt duty amounts to

£3, 2s. 71d. Required the gross bushels.

77. Nineteen tons, 19 cwts. 3 qrs. 27½ lbs. at £19, 19s. 11½d. per

ton; required the amount by practice.

78. A watch was 10 minutes fast at noon on Monday, it gains 3 minutes and 10 seconds per day; what is the time by the watch at 10.15 on the following Saturday morning?

79. The ad valorem duty on a quantity of imports at 82 per cent. amounts to £3863, 2s. 6d. Required the value of the imports.

80. In what proportion should worts of the gravities of 47°, 51°,

and 54° be mixed so as to produce a gravity of 50°?

81. A cask containing 106 gallons at 5 o.p. loses 3 gallons by leakage, and suffers a decrease of 7 per cent. in the strength; it is then mixed with 15 gallons of water and 26 gallons of spirits at 12.8 u.p. Required the strength of the mixture.

82. A man pays $5\frac{1}{2}$ per cent. out of his gross income for insurance, &c.; he then pays on the residue for local taxes 3d. and 4d. in the £; his net income is then £1247, 10s. 5d. Required his gross

income.

83. A and B together earn £3, 16s. in 8 days, A and C together can earn £7, 13s. in 17 days, and B and C together £12, 15s. in 30 days; how much can they severally earn alone?

84. Express 32567325 in the duodenary scale.

85. A merchant selling goods at a certain price loses 5 per cent., but if he had sold them for £4 more he would have gained 3 per cent. What did the goods cost him?

86. Multiply by duodecimals 3 feet 2 inches by 5 feet 7 inches, and the product by 6 feet 8 inches. What does the answer become when expressed in cubic inches and the decimal fraction of a cubic inch?

87. Extract the square root of 109428, and find the side of a cube

containing 2,048,383 cubic inches.

88. What is the present worth of £1801, 11s. payable 61 years

hence at 5 per cent. per annum?

89. A bill upon Amsterdam is bought at 12 florins per £ sterling; the proceeds purchase at Amsterdam bills upon Hamburgh at 34½ florins for 40 marks; these are forwarded to Paris, and sold at 185 francs per 100 marks: what is the rate of exchange between London and Paris?

90. A train is just 27 minutes in passing through the Mont Cenis tunnel, the length of which is 11,220 metres; find the speed of the

train in miles per hour. (A metre=39.39 inches.)

91. In Reaumur's thermometer the freezing point is zero and the boiling point 80°; in Fahrenheit's thermometer the freezing point is 32° and the boiling point 212°. What will Reaumur's thermometer mark when Fahrenheit's marks 47°, and what will Fahrenheit's mark when Reaumur's marks 93°?

92. A and B rent a pasture for £138 per annum; A puts in 200 sheep and B 160, but at the end of six months they dispose of half their stock, and allow C to put in 120; what should A, B, and C

pay severally towards the rent at the year's end?

93. It is noticed that the water in a reservoir 38 feet long and 26 feet wide, which is known to leak, sinks one inch in 12 hours. A pipe discharging 60 gallons per minute will fill the reservoir in 45 hours, allowing for the leakage. Find within an inch the depth of the reservoir. (A cubic foot of water contains 6.25 gallons.)

94. A man invests £26,180 in the 3 per cents. at 93½, but after a time sells out half at 92½, and invests the proceeds in the 4 per cents.

at 97. Find to a penny the difference in his income.

95. Find the value of 3.6 of .954, of .428571 of 2s. 3d.

96. A watch gains one minute and 15 seconds a day. It is set right at noon on the 12th of November. What will be the true time when it points at noon on the following Christmas day?

97. The first of a line of ten sentries standing at equal distances from each other, wishes to send a message of twenty words to the last. The men begin to walk at the same instant, and walk even distances right and left of their posts alternately, and each time they meet pass on five words. The transmission of the message occupies 48 minutes, and the men walk at the rate of three miles per hour.

How far is the first man from the last?

98. Multiply one million one thousand and one by ten thousand

one hundred and one, and write down the product in words.

99. Reduce $\frac{33 \text{ of } 2\frac{11}{13}}{\frac{1}{33} \text{ of } 8\frac{10}{14}}$, and $04 \div 769230$ to their simplest forms.

100. If $\frac{1}{6}$ of a ship be worth £36, 10s. $7\frac{1}{2}$ d., what part of her may

be bought for £125, 5s.?

101. Explain the principle of the rule called "Practice;" and find by means of it the value of 17 cwt. 3 qr. 7 lb. at £4, 17s. 3½d. per cwt.

102. What decimal of a pound is 7s. 71d.? Prove your result by converting back the decimal into its value. Extract the square root of 31 to four places of decimals.

103. A contractor bought 250 sheep, and sold them for £432, 5s. 10d., at a gain of 16% per cent. What was the cost price of each sheep?

104. Explain the difference between interest and discount, and find the present worth of £553, 15s. due 2 years hence at 53 per cent.

105. State the rule for the Equation of Payment, and show that it is in favour of the payer. Find the equated time of payment of £750, of which half is due in 4 months, $\frac{3}{8}$ in five months, and the rest in 6 months.

106. Cube 25; square the result, put a decimal point between the third and fourth digits from the right hand, and then extract the

cube root of the number.

107. A person has a sum of money invested in consols (3 per cents.). He sells out at 87½, and invests the proceeds in railway shares, when a £100 share sells for 174½; by this transaction he increases his income from £120 to £200. What dividend per cent per annum does the railway pay?

108. Find a number of 6 digits with 7 in the units, place such

108. Find a number of 6 digits with 7 in the units, place such that, when the left-hand figure is removed to the right hand, the number thus formed is equal to three times the original number.

109. What will be the cost of painting the walls of a room at 1s. 7d. per square yard; the length being 19 ft. 10½ in., the breadth

16 ft. 12 in., and the height 10 ft. 3 in. ?

110. A lends B a certain sum; at the same time he insures B's life for £737, 12s. 6d., paying annual premiums of £20. At the end of three years, and just before the fourth premium is to be paid, B dies, having never repaid anything. What must A have lent B, in order that he may just have enough to recoup himself, together with 5 per cent. compound interest on the sum lent, and on the premiums?

111. Find, by means of duodecimals, the exact cost of glazing twelve windows, each containing 60 panes 1 ft. 2' 3" long, and

11' 5" wide, at 3s. 8d. per square foot.

112. If the wages of 45 women amount to £207 in 48 days, how many men must work 16 days to receive £76, 13s. 4d., the daily

wages of a man being double those of a woman?

113. A person enters France with 33 sovereigns, 1 half-sovereign, and 7 florins. He spends 577 francs, 50 centimes. How many florins will he receive in exchange for the remainder, if £1 be worth 26 francs 25 centimes?

114. A square field contains 3 acres, 2 roods, 7 poles, 91 yards;

what is the length of its side?

115. If a sovereign containing 112 grains of pure gold and 25 lb. of standard gold is minted into 1200 sovereigns, what is the pro-

portion of alloy in standard gold?

116. A park wall, 1½ bricks thick and 5 feet high, is to be built with 1½ million bricks; how many more bricks would be required to add buttresses half a brick thick, 1½ feet wide, and 4 feet high, at

every fifth yard? A brick is usually 9 inches long, 4½ wide, and 3 inches thick.

117. If the volume of a ton of water be 36 cubic feet and a cubic metre of water weigh 1000 kilogrammes, find the ratio of a kilo-

gramme to a lb. (A metre = 1.1 yards.)

118. A man, having £4400 to invest, buys £1000 stock in the three per cents. at 81, £1500 stock in the three-and-a-half per cents. at 90, and invests the remainder of his capital in four per cents. at 112. What interest does he get per cent. on his whole investment?

119. A prairie fire, spreading from a centre at the rate of 80 feet in a minute, has lasted for an hour, when, meeting with drier grass, its rate is accelerated to the extent of 5 per cent. How much more surface will it cover in the five minutes following than it did in the five minutes preceding the completion of the hour? (Area of a circle is proportional to the square of the radius.)

120. A and B run a 4-mile race, and when A has run 2½ miles B has run 2½. In what ratio must B increase his speed from this

point in order to win by 300 yards?

121. It is proposed to raise the surface of a lawn (the lawn being 100 yards long and 96 yards wide) with the earth obtained by digging a ditch 6 feet wide round the lawn. If the lawn be raised 4 inches, how deep must the ditch be?

122. Which is the better investment, the three-and-a-half per

cents. at 98, or the four per cents. at 108?

If one of these investments gives £50 a year more interest than the other on the same principal, what is the capital invested?

123. A tradesman, who makes 10 per cent. on his capital, allows 2d. in the 1s. discount off the price marked on each article. How much per cent. above cost price does he mark the articles for sale?

- 124. A ship sailing at the rate of 10 miles an hour is observed to move 1 of a mile in the interval between the flash of a gun fired on board being seen, and the report being heard on shore. The velocity of sound being 1140 feet per second and the flash being assumed to be seen instantaneously, how far is the ship from land?
- 125. The price of land about London is every year rising 4 per cent. on previous prices, while the purchasing power of gold as regards general commodities is falling \(\frac{1}{2} \) per cent. per annum. A proprietor sells half his land this year for £8000, and invests the proceeds at 5 per cent. He proposes to sell the remainder three years hence, and to invest the money in the same way. What income would now represent the purchasing power of the income he will have obtained when the sales are completed?

126. Seven francs are worth as much as 2 thalers, 11 thalers as

much as 10 roubles, 8 roubles as much as 7 dollars, and a dollar is worth 3s. 11\frac{1}{2}\ddotd. A man has an equal number of the four coins. What is the least number of coins he can have in order to get an exact number of pence in exchange?

127. Express in figures sixty-seven millions thirty-five thousand and twenty-four, and in words 1110011100111. Also express the

sum of $\frac{1}{2} + \frac{1}{6} + \frac{12}{12} + \frac{101}{101}$ as a vulgar fraction.

128. Find to four places of decimals the square root of 19, and find the cube root of 206.425071.

129. Find the greatest common measure of 8214, 1110, and 1702; also find the least common multiple of 11704, 101080, and 138945.

130. Find the value of $\frac{3\frac{7}{8} \times 1\frac{1}{17} + 4\frac{1}{18} - 3\frac{1}{18}}{5\frac{1}{8} - 7\frac{7}{8} \div 28\frac{7}{20} + \frac{1}{8}}$, and divide 0003 by

0004.

131. Which is the better investment, a stock paying 3½ per cent.

at 88, or one paying 4.4 per cent. at 96%?

132. A clock loses 5 seconds in every 24 minutes. At 10 P.M. on Sunday it is 19 minutes fast. When will it be at the right time exactly?

133. Find the difference between the amounts produced at compound and simple interest respectively by a capital of £1760 at 5 per cent, per annum for 2½ years, the interest being payable half-

yearly.

134. If 3 men working 4 hours a day can build a wall 80 ft. long, 6 ft. high, and 2 ft. thick in 5 days, how many men working 3½ hours a day will be required to build a wall of similar materials 100 ft. long, 7 ft. high, and 4 ft. thick in 25 days?

135. Find, by practice, the value of 11 tons, 6 cwt. 1 qr. 19 lbs.

at £4, 1s. $10\frac{1}{2}$ d. per ton.

136. If the discount on a bill due five months hence at 32 per cent. per annum is £774, 12s. 6d., what is the amount of the bill?

137. A room is 38 ft. 3 in. long, and 25 ft. 6 in. wide. How many yards of carpet 1 yard broad will be required for the floor, if a margin of 9 in. in width is left uncarpeted all round the room?

138. Three taps, A, B, and C, can fill a cistern, A by itself in 24 minutes, B in 10 minutes, and C in 27 minutes. They are all three turned on at once, and after running for 4½ minutes B and C are turned off. How long will A then take by itself to complete the

filling of the cistern?

139. Two trains on the same railway are running past each other in opposite directions, one 40 and the other 30 miles per hour. Each has an engine and tender; the first has 12 carriages and the second 17. If the length of an engine and tender be 40 ft., and the length of a carriage 32, and the coupling spaces be each 5 ft., how much

time will elapse from the moment that the engines meet till the last

carriages of each train have passed each other?

140. A man spends a certain capital as follows:—He buys 18,000 acres of uncultivated land, one-third at 27s. an acre, one-third at 33s., and one-third at 33s.; he has the land cleared and ploughed at 8s. an acre, and builds farmhouses at a cost of £6400. He then leases 16,000 acres at a yearly rent of 7s. an acre, the farm buildings being let at the rate of 2s. 3d. per £ on their cost price; the remainder of the land he leases to a railway company at 8s. an acre. How much per cent. per annum does he make on the original outlay?

Examinations of Candidates for Admission into Training Colleges.

Paper 34.

MIDSUMMER, 1877. (MALE CANDIDATES.)

[Three hours allowed for this paper. Only one question to be answered in each section.]

Section I.

Express in figures thirty billion ninety-five million seventy thousand and five.

Express the year 1988 B.C. in Roman numerals.

How many times can 75 be subtracted from 6075 so as to leave a remainder equal to itself?

Divide the continued product of 17, 18, 19, 23, 301, 113 by the difference of 259867 and 126145.

[These form one question.]

Section II.

1. In a bag are 90 shillings, 100 sixpences, and 120 fourpenny pieces; find the least number of threepenny pieces that must be added so that the whole may be distributed in sums of eighteenpence, no such sum being made up of any one coin exclusively.

2. An orphan asylum contains 120 children, each of whom consumes 40 oz. of meat per week; find the weekly saving effected by using American beef at 6d. per lb., allowing also 2s. 4d. per cwt. for carriage, in place of English beef at 6s. 4d. per stone of 8 lbs.

3. The length of the solar year being 365 days 5 hrs. 48 min. 50 sec., and the Chinese civil year consisting of 12 months of 29 and 30 days alternately, how many months of 30 days must be added in the course of 60 years that the Chinese civil year and the solar year may agree most nearly?

Section III.

Make out the duty payable on the following goods :-7000 lbs. of coffee at 14s. per cwt. 6252 packs of cards at 3s. 9d. per dozen packs. 670 lbs. of gold plate at 17s. per oz. 90 bushels of malt at £1, 4s. per qr.

Section 1V.

Find, by practice, the value of-

1.15 cub. yds. 21 cub. ft. 648 cub. in. at £4, 4s. per cub. yd., or 2.75 miles 5 fur. 9 chains 24 yds. at £56 per mile.

Section V.

1. A tradesman sold some goods at 15 per cent. above the price at which he bought them; the two prices together amounted to £733, 3s.; find the price at which the goods were bought.

2. A block of granite 16 ft. long 8 ft. broad 4 ft. deep stands on one of its broadest faces; the other faces are polished at a cost of £16; find the cost of polishing similarly another block 24 ft. long

10 ft. broad 5 ft. deep similarly placed.

3. The earth's orbit is 446,000,000 of miles, and is traversed in 3651 days; the distance of the earth from the sun may be reckoned as 71,000,000 of miles, and light travels at the rate of 186,000 miles per second; how far will the earth travel on its orbit while a ray of light is travelling from the sun to the earth?

Section VI.

1. Show that $\frac{7-\frac{8}{13}}{13-\frac{15}{14}} + \frac{1\frac{2}{3}}{3\frac{1}{4}} \div 1\frac{2}{3} = \frac{1}{2}$ of $6\frac{17}{18}$.

2. Reduce $2\frac{1}{2}$ cwt. to the fraction of 4 tons 2 cwt. 14 lbs.; and $19\frac{1}{2}$ guineas to the fraction of £14, 9s. 3d. Show that $\frac{2}{3}$ d. and every

multiple of it will give a terminating decimal of £1.

3. If 75 of an estate be worth 200 guineas, and the value of the estate be increased 075 per cent. by improvements, find the value of 22 of the improved estate.

Section VII.

1. Express as decimals $1\frac{3}{60}$, $7\frac{1}{15}$, $\frac{1}{5}$. Show that $\frac{1}{7} + \frac{1}{70} + \frac{1}{700} + \frac{1}{60}$.

2. Find the value of (3+8) of 4 guineas +(09-01) of £2, 1s. 3d.

 $+ (5.05 \div .005)$ of 5s.

3. The rainfall of London in the months of April, May, June, 1876, was 1.90, 0.94, 1.27 inches respectively, being in April 0.77 above and in May and June 1.46 and 1.78 inches respectively below the averages of those months for the previous six years; find the average for these three months both for the year 1876 and for the whole seven years to two places of decimals.

Section VIII.

1. Which of the following stocks is most profitable for investment, the 3 per cents. at 91½, the 3½ per cents. at 108½, the 4 per cents. at 118? Find the yearly income produced by investing £5217, 16s. 3d. in the most advantageous of the three.

2. A tradesman induces customers, who owe £750, and otherwise would not have paid him for six months, by offer of 5 per cent. discount, to pay ready money; at the end of six months instead of £750, he had received £947, 12s. 6d. What is his profit per cent.?

3. A commission agent agrees to take 5 per cent, on all sales or f of net profit; 35 of his transactions realise 10\frac{1}{2} per cent. profit, the remainder 19\frac{1}{2} per cent. What would be the difference on sales of £600,000, according as his customers adopt one or other agreement?

Section IX.

1. Find the square root of 32'7142073 to four places of decimals, and the cube root of 941192. Show that the cube root of every perfect cube less than a million can be determined by inspection.

2. If exchange be at the rate of 25.50 francs for one pound, and of 57.75 florins for 119 francs, find the value of £4760 in florins.

Section X.

1. Find the cost of turing a ground 10 chains long and 5 chains broad, each turf being 15 ins. long and 6 ins. broad, and 100 turfs

costing 1s. 3d.

2. £8, 11s. is spent on the floor of a room 24 ft. long and 18 ft. wide, the centre of the room is covered with carpet 2 ft. wide at 4s. 3d. per yd., leaving a margin of three feet all round the carpet; how much per sq. ft. does the margin cost to paint?

FEMALE CANDIDATES.

Section I.

Add together nine million nine hundred and nine thousand and ninety-nine; seven hundred and forty thousand and forty-seven; six million twenty thousand and two hundred; eight thousand and eighty-eight; thirteen million one hundred and thirty thousand and four hundred. From the sum subtract four million four hundred and six thousand three hundred and sixty-seven, and divide the remainder by 94.

Section II.

Divide £7,483,192, 2s. 7½d. by 803, and prove your sum by multiplication.

Section III.

Make out the following bill of parcels:—

17 lbs. of candles at 4½d. per lb.

7½ lbs. of tea at 2s. 3d. per lb.

27 lbs. of rice at 3½d. per lb.

42 lbs. of sugar at 2ls. the cwt.

11½ lbs. of currants at 2d. per lb.

½ cwt. of soap at 3½d. per lb.

220 oranges at 7½d. per dozen.

Section IV.

Find by practice the value of 8 trucks of coal, each weighing 9 tons 12 cwts. 21 lbs., at 14s. 7d. per ton.

Section V.

- 1. What would be the half-yearly dividend from an investment of £3300 in the 3½ per cents, made when the stock was standing at 91?
- 2. What sum of money must be invested in the 5½ per cent. stocks at 83 to enable the possessor to realise an income of £64, 3s. 4d. per calendar month?

Section VI.

1. What would be the expense of painting (at 3s. 2d. a sq. yd.) the walls of a room 27 ft. long, 17½ ft. broad, and 11½ ft. high, the dimensions of four windows being 7½ ft. by 4 ft. each?

2. What length of carpet \(\frac{3}{2} \) yds. wide would be required to cover the above room \(\frac{2}{3} \) and what would be the cost at 5s. 3d. per yd. \(\frac{2}{3} \)

Section VII.

1. Divide £10, 10s. between A and B, so that $\frac{1}{2}$ of A's portion shall equal $\frac{2}{3}$ of B's.

2. If 3\(\frac{2}{3} \) of a yard of French merino cost £1, 14s. 4\(\frac{1}{3} \) d. what would \(\frac{1}{3} \) of \(\frac{1}{3} \) of a yard cost \(\frac{1}{3} \)

Section VIII.

1. Prove the rule for multiplication and division of decimals.

2. Find the value of $7.92 \div 3.84$ and $1003.53 \div 1250$ and of $8 \times 0.06 \times 0.032$.

Section IX.

1. What is the percentage gained by the newspaper-boys who buy the daily papers at 9d. per dozen, and sell them at 1d. each? Explain your answer.

2. Describe ratio, and illustrate your definition by an example.

3. If 25 men could set up a mile of telegraph wire in 24 days of 8 hours work, what length of wire would 20 set up, working 10 hours a day for 20 days?

Paper 35.

MIDSUMMER, 1879. (MALE CANDIDATES.)

[Three hours allowed for this paper.]

Candidates are not permitted to answer more than one question in each section.

The solution must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

Section I.

Add together three hundred and six dozen, five hundred and ninety score, and one hundred and seven gross.

Express in words the largest number that can be formed with the

digits 1,0,0,8,0,0,9,1,9,6.

A million and a quarter of passengers are carried by rail in a certain week, and the average journey of each passenger is seventeen miles; find the average payment per mile, the sum received for

fares amounting to one hundred and thirty-two thousand eight hundred and twelve pounds and ten shillings.

(These form one question.)

Section II.

1. A sum of prize money is divided among 720 soldiers; each receives 5s. 4d. less than each of 960 soldiers among whom a sum of

£4004 is divided; find the amount of the former sum.

2. The first, second, third-class fares on a railway are 3d., 2d., 1d. per mile respectively; find the distance travelled by two men, one of whom travels first-class one quarter of the distance, and the remainder second-class, and pays 8s. 9d. more than the other man, who travels third-class all the way.

3. A man pays three bills, the first in half-crowns, the second in florins, the third in shillings, the number of coins in each case being equal; the amount of all the bills is £40, 14s.; find the amount of

each separately.

Section III.

Make out the following bill :-

27 dozen shirts, at 2s. 9\flackdd. each.

59 coats at 25s. 4d. each.

81 vests at 11s. 9d. each.

50 dozen pairs of boots at 37s. 6d. per half doz.

950 pairs of trousers at 87s. 9d. per score.

Section IV.

How many bricks, whose length, breadth, and depth are 8²/₄, 4¹/₂,
 in. respectively, can be stored in a space 17¹/₂ yd. long, 10 yd.

broad, 81 ft. high?

2. How many feet of boarding will be required for a roof 72 ft. long and 1916 ft. deep, the boards being 9 ft. long and 5½ in. deep, if the longer edge of each is laid horizontally and overlaps the lower board by three-quarters of an inch?

Section V.

1. If £1,250,000 are raised by a tax of 10d. per lb. on tobacco, find the diminution in the consumption when the tax is raised to

1s. 1d. per lb., but brings in only £1,619,583, 6s. 8d.

2. The top of a building, 236 ft. high, is reached by a flight of steps each 12 centimetres high, find the number of steps, a metre being taken as equal to 3 ft. 3\frac{1}{3} in.

Section VI.

1. Reduce to its lowest terms $\frac{49784}{64008}$.

Reduce 5 ac. 3. r. 4 po. 7 yd. to the fraction of 5 ac. 1 r. 18 po. 61 yd.

2. What fraction of £22, 15s. is equivalent to $\frac{2}{158}$ of £30, 12s?

Section VII.

1. Express as vulgar fractions '07, '007, '0007. Divide 451807'32 by 571'908.

Find in feet to two places of decimals the length of a sheet of

lead 19 in. broad which covers 233 sq. ft.

2. How often is 9.75 of half a guinea contained in \$ of 29.25 of 63,000 francs, each franc being equivalent to 10.25d. ?

Section VIII.

1. What is the total income on which a tax of 5d. in the pound is levied, if the tax produces £113, 5s. 3d. after deducting 15 per cent. for cost of collection?

2. How many railway shares at £77 each are equivalent to

£50,400 stock at 931?

3. £800 is put out at interest at 5 per cent. per annum, and at the end of each year £120 is deducted for the expenses of the next. What is left of the original capital at the end of the sixth year?

Section IX.

1. Find the square root of 160, and the cube root of 8.1, each to

two places of decimals.

2. The longer sides of two rectangles are 189 and 244 yd., their shorter sides 45 and 36 yards; find the area of a square that is intermediate in area to the two rectangles, and whose side consists of an exact number of yards.

Section X.

1. In a certain town nine schoolmasters receive annual salaries amounting to £1109, 2s.; 17 schoolmistresses and 19 pupil teachers receive salaries amounting to £1602, 0s. 8d., the average salary of a pupil teacher being one-fifth of that of a schoolmistress; compare the average salary of the schoolmaster and the pupil teacher.

2. In a co-operative factory how should a sum of £125, 3s. 5d. be divided among three workmen, who work 8, 9, 10 hours per day respectively, and whose rates of production per hour are also in the same ratios, and who have employed 10, 11, 12 days respectively on

the work.

Paper 36.

MIDSUMMER, 1880. (FEMALE CANDIDATES.)

Section I.

1. Multiply £70,396, 17s. $4\frac{1}{2}$ d. by 378, and prove your result by division.

2. Divide 1290 tons 12 cwt. 1 qr. 24 lb. 5 oz. by 73, and prove your result by multiplication.

Section II.

What is the value of 2 tons 13 cwt. 3 qr. 11 lb. of rice at 3\(\frac{3}{2}\)d. per lb., and what would be the difference if the price were reduced \(\frac{1}{2}\)d. per lb.?

Section III.

Make a bill of the following articles, and deduct 2d. in the shilling for ready money:—

17 reams of paper at 9½d. for 5 quires.
13½ dozen copy-books at 3½d. each copy-book.
4 gross of steel pens at the rate of 8 for 1d.
17 packets of slate pencils at 7½d. per packet.
200 slates at 2s. 6d. per dozen.

Or.

67 yards of long cloth at 5½d, per yard.
29 pairs of stockings at 1s. 9½d. per pair.
85 straw bonnets at 4s. 3d. per dozen.
235 yards of ribbon at 3s. 9d. per score yards.
57 yards of print at 9½d, per yard.
29 yards of silk at 3s. 7½d, per yard.
And deduct 5 per cent, for ready money.

Section IV.

1. Find by practice the value of 9 acres, 1 rood, 16 perches of land at ± 1 , 1s. 8d. per acre.

2. Find by practice the value of 37 lb. 4 oz. 16 dwt. of silver at £3, 4s. 9\frac{1}{2}d. per lb.

Section V.

1. If the railway fare for 113 miles be 18s. 1d., what ought the fare to be for 69 miles?

2. A rate of $1\frac{1}{2}$ d. in the £ is required to raise a sum of £525, 12s. 6d.; what is the rateable value of the town?

Section VI.

If I give £1, 10s. 11 $\frac{1}{2}$ d. for $4\frac{1}{2}$ yards of velvet, what quantity could I purchase for £14, 1s. $10\frac{1}{2}$ d.?

Section VII.

1. Explain what you understand by multiplication by a fraction, and multiply 7 tons 4 cwt. 1 qr. 15 lb. by 232.

2. Add together $\frac{2}{3}$, $\frac{7}{3}$, $\frac{2}{10}$, and $\frac{7}{32}$, both as vulgar and decimal fractions, and show that the two results coincide.

Section VIII.

1. What decimal is 3s. 7½d. of 18s. 2¾d. ? Divide 299 by ·13, and ·3525 by 7110.

2. Find the value of 3.275 of £10; multiply 3.275 by 12.8; and divide .0625 by .00005.

Section IX.

1. A tradesman commenced business with a capital of £3200; he increased his capital at the rate of 15 per cent. for 5½ years, simple interest; what is its present amount?

2. At what rate per cent., simple interest, will £2700 amount to £3219, 15s. in 7 years.

Paper 37.

MALE CANDIDATES.

The solution must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

Section I.

Arrange the digits 58967537, so that the number formed may be divisible by 19.

How many times can 692 be taken from 4676536?

A man buys 300 quarters of corn for 1000 guineas; he sells one hundred at £3, 10s. per quarter; another hundred at 10s. per bushel; and the remainder at 1s. 6d. per gallon. Find the total gain.

(These form one question.)

Section II.

1. If 50 gallons of water weigh 525 lb., and a cubic inch of water weighs 7 oz., find the number of gallons in a tank containing 1840 cubic feet.

2. If the ratio of the diameter of a circle to the circumference = \sqrt{s} , find the length of the earth's diameter, the length of a degree of

latitude being taken as uniformly equal to 691 miles.

3. If the total annual yield of all the gold mines of the world is 4,788,000 oz., find the number of gold coins that could be coined from 15 of the yield, so that 260 such coins can be made from 5½ lb. of gold.

Section III.

1. A certain fraction exceeds $7\frac{1}{8}$ by $5\frac{5}{12}$, another is less than $5\frac{1}{6}$ by $3\frac{1}{2}$; find the product of the sum and difference of the two fractions,

2. If the franc in silver coinage is equivalent to $9\frac{3}{2}$ d. and in depreciated paper money to $8\frac{3}{2}$ d., find the loss incurred by paying bills to the amount of £100 in the former currency instead of in the latter, reckoning $25\frac{1}{2}$ francs to the pound.

Section IV.

1. Reduce $5\frac{7}{6}$ of a guinea $+\frac{3\frac{9}{6}}{6}$ of 13s, $4d.-4\frac{11}{12}$ of a crown to the decimal of $\frac{9}{10}$ of $\frac{9}{6}$ of £1, 7s, 6d.

2. Arrange in order of magnitude the fractions 06, 06, 069, 069,

'069, and express their average decimally.

Section V.

Write out clearly and concisely the rules for

(a) Converting circulating decimals into vulgar fractions,(b) For the extraction of the square root of a perfect square

consisting of four digits,

(c) For the multiplication of numbers mentally by 25 and

625. (These form one question.)

Section VI.

Find, by practice, the value of 504k articles at £5, 13s. 4d. each, and of 17 ac, 1 r. 25 po. at £250, 10s. per ac. (These form one question.)

Section VII.

1. An engine can pump out 1600 gallons per hour; after working for 19 hours it has pumped out 36 of the contents of a reservoir; in what time will it pump out the remainder with the help of another engine, whose power is 33 of its own, and how many gallons will each have pumped out?

2. If 27 men and 60 boys earn £134 in 17 days, how much will 18 men and 24 boys earn in 23th days, a boy's earnings being & of

a man's?

Section VIII.

1. Find the edge and longest diameter of a cubical tank, which

contains 134,217,728 cubic inches.

2. Find the cost of desk accommodation for a school of 168 children at 3s. 6d, per linear foot, each child requiring 21.75 inches; find also the average space in square feet per child, if the room contain 8 equal groups of desks, three deep, each group occupying 152.25 square feet, with 8 gangways occupying 288 square feet, and a space of 10 feet is left clear in front of the desks.

Section IX.

1. Find the compound interest on £3600 for 2½ years at 5 per

cent. per annum, the interest being payable half-yearly.

2. Part of a sum of £3000 is invested to produce 3 per cent, per annum, and the remainder 42 per cent.; if the interest on the whole for a year amounts to £122, 9s. 104d., find the sum invested at each rate.

Section X.

1. Divide a sum of £2529, 12s. between A, B, and C, so that A's

share may be 3 times B's, and A's and B's together 5 times C's.

2. In a school which has on its books 250 children uniformly, 18 per cent. are absent during the former half of the year, 121 per cent. during the latter half; in the former there are 3 weeks of holidays, in the latter 5; reckoning the full weekly attendances of a child at 10, find the average attendance for the year, and the average number of attendances made by each child, reckoning 52 weeks to the year.

General Examinations in Training Colleges.

Paper 38.

CHRISTMAS, 1876. (Male Candidates.)

First Year.

[Two hours and a half allowed for this paper.]

The solution must in every instance be given at full length. A correct answer, if unaccompanied by the solution, or if not obtained by an intelligible method, will be considered of no value.

Section I.

1. Multiply fourteen million two hundred and forty-five thousand nine hundred and twenty by four thousand one hundred and ninety-nine, and divide the product by four thousand eight hundred and forty-five.

2. Find the least multiple of thirteen that can be expressed by nines only, and subtract this multiple from ten million ten thousand

and one

3. A man buys 497 sacks of potatoes for £339, 1s. 11\frac{2}{4}d., and sells 248 sacks for 17s. 9\frac{1}{2}d. per sack, the remainder for 18s. 2\frac{1}{2}d. per sack; find the total gain.

Section II.

1. Make out the following bill, allowing 5 per cent. discount:-

95½ yards of calico at 10¾d, per yard. 12 dozen blankets at 14s. 9d. per pair. 50 gross of buttons at 3½d, per dozen. 70 score of handkerchiefs at 8 for 3s. 6d.

2. A man engages to ride 500 miles in 60 hours; he rides every 2 miles at an average rate of 111 minutes, and stops every 40 miles

for an hour's rest; how much time has he to spare?

3. Find the expenses of an excursion, which includes 5782 miles of railway at \(\frac{3}{4}\)d. per mile, 517 miles of carriage at 10\(\frac{1}{2}\)d. per mile, 57 days of hotel keep at 14s. 3d. per day, allowing 5 guineas for extras.

Section III.

- What illustrations would you place on the black board to show the truth of the following expressions:-

(a) \(\frac{3}{3} \) of \(\frac{8}{5} = \frac{15}{15} \).
(b) \(\frac{3}{3} + \frac{3}{4} = \frac{1}{15} \).
(c) The number of yards of carpet 18 in. wide required for a room 12 ft. long and 9 ft. broad is 24.

(d) $3.5 \times .2 = .7$.

(Two such illustrations will be considered equivalent to a complete answer.)

Section IV.

- 1. Express 2304, 1728, 1296 as powers of prime numbers, and hence find their greatest common measure and least common multiple.
- 2. Simplify the expression $\frac{\frac{1}{3}+3\frac{1}{4}}{3+5\frac{1}{3}} \div \frac{4\frac{1}{7}}{7}$ and find the number of lbs. in $3\frac{1}{4}$ of $5\frac{1}{2}$ tons $+4\frac{7}{16}$ of 62 cwt. $+1\frac{4}{7}$ of 513 qrs.
- 3. Three-sevenths of the agricultural land of a district is arable, 75 pasture, 2 of remainder woodlands, the remaining 1800 acres are common; find the number of acres in the whole and the relative size of each kind of land.

Section V.

1. Divide 37.2812 by .00407, and prove the result by vulgar fractions.

Also find the value of 3.75 of 5s. 6d. + 5.05 of £3, 1s. 8d. + 5.07of 7s. 6d. + 3.135 of £2, 1s. 3d.

Find the square root of 8658:3025 and the cube root of 753:571.

3. In 1861 three towns had populations of 17,341, 15,540, and 18,760 respectively. In 1871 it was found that the population of the first had decreased 17 per cent., that of the second had increased 19 per cent., while the population of the three had increased by 5000; find the increase or decrease per cent. in the population of the third town.

Section VI.

1. Find the value of $581\frac{1}{8}$ articles at £3, 11s. 9d. each, and of

29 oz. 5 dwt. 16 grs. of gold at £3, 17s. 9d. per oz.

2. A bankrupt has £975 worth of goods in stock, his creditors would have received 14s. 9d. in the pound if the goods had been sold for cost price, but \$\frac{2}{3}\$ of the goods are sold at 17.75 per cent. below cost price, and the remainder at 21.75 per cent. below cost price; for what were the goods sold, and what dividend is paid?

3. A piece of work can be done by 40 men working 10 hours a day for 17 days; how long will 17 men, 17 women, and 17 children over 10 years of age, take to do it, each child working 4 hours a day, and its working power in a given time being equal to one-third of a man's, each woman working 6 hours, and her power being equal to two-thirds of a man's, each man working 8 hours a day.

Section VII.

1. Find the present value of £1565, 2s. 350d., due 4½ years hence, at 5½ per cent. simple interest.

2. Find the amount of £5750 for 6 years at 5‡ per cent., allowing

£175 for annual expenditure.

3. The French 5 per cents, being at 105\(\} and the English 3 per cents, at 96\(\} ; find the loss of income caused by transferring £5000 French stock into English stock, and the value of the stock in English money.

Section VIII.

1. Twelve thousand five hundred and forty pound has to be divided between A, B, and C, so that A shall receive three-sevenths of B's and C's shares, B shall receive two-ninths of A's and C's; find the share of each.

2. Three boys run a race of $2\frac{1}{2}$ miles; A starts 4 minutes before B, and runs at the rate of $5\frac{3}{4}$ miles per hour; B starts 2 minutes before C, and runs at the rate of $6\frac{1}{4}$ miles per hour; C runs at the rate of $6\frac{3}{4}$ miles per hour. Find which will win the race, and the

intervals between the arrival of each boy at the post.

3. Two clocks, one of which gains 3 min. 25 sec. daily, and the other loses 4 min. 15 sec. daily, at 12 o'clock on Monday are respectively 13 min. behind and 14 min. before the true time; what time will be told by the first clock and on what day, when the second tells the true time.

Paper 39.

CHRISTMAS, 1878. (MALE CANDIDATES. First Year.)

[Two hours and a half allowed for this paper. Only one question to be answered in each section.]

Section I.

Give rules for calculating mentally the price of 99 dozen at 9d.

per dozen, of 940 articles at 1s. 3d. per score, and for multiplying 9848 by 625.

Write down the factors of 4335.

Divide £479, 4s. 8d. among 35 men and 18 women, giving each woman half the share of a man.

[These form one question.]

Section II.

1. 1216 shirts can be made from a certain quantity of material, allowing 3% yds. to each shirt; if 4 yds. are used for each shirt, how

many fewer will be made?

2. A man's weekly wages are 43s., the keep of his family of seven costs him 3s. 91d. per head per week; in 27 weeks he has saved £3, 1s. 104d.; what is the average weekly amount of his other expenses?

3. A man saves out of his annual income £95, 17s. till an increase in the income-tax of 3d. in the pound reduces his annual saving to

£85, 15s. 11d.; what is his annual income?

Section III.

1. Why must fractions be reduced to a common denominator before addition?

Reduce to its lowest terms 1888; and find the side of a square

whose area is $10\frac{8}{25}$ sq. yds.

2. State the method by which you find the least common multiple of several numbers.

Find the value of-

 $(8\frac{1}{6})$ of $346\frac{1}{2}$ of 4 of $\frac{18}{561}$) $\div (2\frac{11}{6})$ of $13\frac{18}{18}$). 3. Prove the rule for the multiplication of fractions. Express in threepenny pieces the value of-# of 6} of 341# guineas.

Section IV.

1. Explain why $\frac{7}{55}$ cannot be converted into a terminating decimal.

Supposing the earth to revolve round the sun in 365,242,264 days, explain why Leap day should be omitted once in each three centuries out of every four.

Find the value of 7.35 of 5 cwt. + 05 of a ton + 9.3 lb.

2. Prove the rule for the multiplication of decimals.

Reduce 00003648 to a vulgar fraction in its lowest terms. Multiply £39, 4s. 2d. by 7.09.

3. Two decimal fractions are together equal to 31.4178; one of these is 1 of the other; find the two fractions.

Section V.

1. A coal dealer buys two equal lots of coal at the same price; he retails them at a profit of 13 and 14 per cent. respectively, making a total profit of £168, 17s. 3d.; what did he pay for each lot of coals?

2. How many days of 9½ hours each must 92 men work to do ½

of the work that 95 men could do in 23 days of 10 hours each?

3. A man travels from England to India in 24½ days, partly by land, partly by water; his rate of travelling is 30 miles per hour by land and 12 by water; if he could have travelled all the way by land, he would have finished the journey in 16½ days. Compare the distances travelled by land and by water.

Section VI.

1. Find the difference between the interest and discount on £7300 for 42 days at 5 per cent.

2. At what rate should interest be charged on £550 for 117 days,

to equal the interest on £650 for 55 days, at 41 per cent.?

3. What is the present value of £2100, to be paid in four equal instalments at the end of every fifth year at 5 per cent, simple interest?

Section VII.

1. What capital should be invested in a 5 per cent, stock at 96½ to produce the same income as £2120 invested in a 3 per cent. stock at 77?

2. A man buys 4830 yds. of cloth at 3s. 4d. per yd.; if he sell one-third at a gain of 20 per cent., and the whole at a profit of £187, 16s. 8d., what is the gain per cent. on the other two-thirds?

3. A man sells out of 4 per cent. stock at par and invests in 3 per cent. stock at 86; he sells out at $88\frac{1}{2}$ and re-invests in the 4 per cent. at par; his income is raised by £177; what amount of stock did he originally hold?

Section VIII.

1. A rectangular trough 4 in. deep, 3\frac{3}{4} ft. wide, 2\frac{1}{2} yds. long, contains 72 gals.; find the depth of another rectangular trough whose end contains 165 sq. ins., and which contains 132 gals.

2. If a lb. avoirdupois contain 7000 grains troy, and 133 pennies weigh 64 oz. avoirdupois, find the weight in lbs. troy of a bag

containing 1368 pennies.

3. If silver is worth 53.9d. per oz., and gold £3, 18s. 7.25d. per oz., compare the weights of equal bulks of gold and silver, a bar of silver worth £12, being equal in bulk to a bar of gold worth £100.

Paper 40.

CHRISTMAS, 1879. (MALE CANDIDATES. First Year.)

[Two-and-a-half hours allowed for this paper.]

Candidates are not permitted to answer more than one question in each section.

The solution must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

Section I.

1. How many multiples of four hundred and seventy-nine lie between fourteen hundred and one million five hundred and thirtynine thousand and twenty-seven?

2. What is the effect upon the remainder, if the divisor be

increased by a small quantity without altering the quotient?

3. What is the average weight in lbs. of 9 hams arranged in a row, if the ham at one end of the row weighs 1½ qrs. and the weight of each of the others in succession is greater by 36 oz. than the weight of the ham next preceding it in the row?

4. How many houses can be built on a frontage of \$\frac{2}{3}\$ of a mile, each house having a frontage of 36 ft. 8 ins., allowing for 11 streets,

each having a width of 40 feet?

[These form one question.

Section II.

1. An emigrant ship allows 64 cubic ft. of luggage for each person, and requires 10d. for each cubic foot in excess of this allowance: a man pays £7, 13s. 4d. excess for his own, his wife's, and his daughter's luggage; how many cubic ft. of luggage does the man take, if his wife and daughter each take half as much again as he did?

2. A span of 16 oxen can draw a load of 4½ tons for a distance of 7 miles per day; a man carrying 112 lbs. can travel 21 miles per day; how much more will be carried by 120 men a distance of 147 miles (the men going and returning at a uniform rate) than by two spans of oxen?

3. A railway reduces its fares for first-class passengers from 3d. to 2d. per mile, and for second-class passengers from 2d, to 1½d. per

mile; before the change of fares 10,000 persons travel second-class daily between two towns and 1600 first-class; after the change of fares, 10 per cent. of the second-class passengers begin to travel first-class, but the total number of second-class passengers is increased by 50 per cent. Find the total gain per train mile.

Section III.

1. Prove the rule for division of vulgar fractions. Find the value of—

 $\frac{2\frac{1}{3} + 3\frac{1}{4} + 7\frac{1}{12}}{3\frac{5}{6} - 2\frac{1}{12}} \times 2\frac{3}{11} + (4\frac{3}{4} \text{ of 8.})$

2. Find by successive divisions the greatest common measure of 652,674 and 1,475,600. How would you prove to your class without actual division that your greatest common measure will divide any of the divisors you have used?

3. Find the value of $7\frac{1}{56}$ of 5 guineas $+4\frac{2}{18}$ of £3, $-27\frac{1}{26}$ of 5s.,

and bring the result to the fraction of 1s. 3d.

Section IV.

Convert to decimal fractions 5¹/₁₅, 7¹/₁₆, 8⁷/₅, 1⁹⁰/₁₂₆.
 The length of a metre is 1.09363 yards; convert 150¹/₂ English miles into kilometres.

2. Prove the rule for multiplication of decimals. Find the value

of ·1590 of 11 cwt. 0 qrs. 5 lbs. 8 oz.

3. Two sums of money are in the ratio of .52:16, and their difference is £12, 16s. 2d.; find the sums.

Section V.

1. If 49 men working for 64 days of 7½ hours can excavate a pit with vertical sides whose edges form a square (each edge being 14 yds. long), how many hours a day must 128 men work for 29 days to excavate a pit of the same depth, but longer and broader by 2 yds. each way?

2. A company possessing £500,000 capital carries forward at the beginning of the year £1082, 10s.; at the end of the year a dividend of 5 per cent. is paid, and £1178, 18s. 8d. is carried forward; find the gross receipts, the cost of working being to the net receipts in

the ratio of 53:47.

3. If a quantity of silver bought at 4s. $8\frac{1}{2}$ d. per oz. has lost in value £19, 6s. $8\frac{3}{2}$ d. when silver is sold at £2, 11s. 9d. per 1b., find the weight of the silver.

Section VI.

1. What is the relation between discount, present worth, and amount?

In how many years will £675, 10s. amount to £945, 14s. at

4 per cent. simple interest?

2. A bankrupt's debts amount to £3750; he pays 13s. in the pound, and defrauds his creditors by concealing } of his assests; find the value of his estate.

3. A man invests £4000 in four sums of £800, £900, £1100, £1200, to produce $2\frac{1}{2}$, 3, $3\frac{1}{4}$, and $3\frac{1}{2}$ per cent. simple interest respectively per annum; find the gain in income if the whole had been invested to produce $3\frac{1}{4}$ per annum.

Section VII.

1. Find the square root of 38259 36, and the cube root of 7077 888.

2. A metal is mixed with each of two others in the ratio of 7:8 and 5:6 respectively, and its value is to those of the others as 3:1 and 4:1 respectively; find the value of a quantity of the second mixture equal in weight to a quantity of the first that costs £3190.

3. A charity sells out £10,000 consols at 97½, and invests the proceeds in railway debentures at 160; what interest must the debentures pay that the income of the charity may be increased by

£89 per annum, no charge being made for brokerage?

Section VIII.

1. Two rooms whose breadths are 17 and 15 ft., lengths 19 and 16 ft., and heights 10 and 9 ft. respectively, are covered with papers of different values, each 2 ft. wide; if the difference in the two costs be £1, 7s. according as the larger room is papered with the dearer or cheaper paper, find the difference in price per yd. of the paper.

2. Copper is 8.96 times as heavy as water; what will a cube of copper whose edge is 9 ins. weigh when suspended in water if it lose a weight equal to that of the water displaced, a cubic foot of water

weighing 1000 ounces?

3. Three clocks occupy respectively 33, 22, 11 seconds in striking twelve, and lose 36, 24, 12 seconds daily respectively; if they begin to strike together at 4 P.M. on March 31, on what day will they all strike twelve separately for the first time? which two will first strike twelve separately?

Paper 41.

FEMALE CANDIDATES. First Year.

[Two-and-a-half hours allowed for this paper.]

No candidate is permitted to answer more than one question in Section IV. or Section VI., or more than two questions in each of the other sections.

The solution must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

Section I.

1. From March 1847 to March 1879 there landed at the port of New York two million one hundred and sixty-five thousand two hundred and thirty-two German immigrants; two million twenty thousand and seventy-one Irish: seven hundred and forty-two thousand two hundred and seventy-one English; one hundred and sixty-one thousand five hundred and thirty-seven Scotch; one hundred and twenty-four thousand seven hundred and three Swedes; one hundred and ten thousand eight hundred and fifty-three French; eighty-five thousand nine hundred and forty-six Swiss; fifty thousand five hundred and eighty-one Italians; forty-nine thousand and ninety-seven Norwegians; forty thousand one hundred and three Dutch; thirty-six thousand nine hundred and ninety-three Danes; twenty-eight thousand and eighty-six Russians; ten thousand four hundred and ninety-six Belgians; eight thousand nine hundred and fifty-two Spaniards. Find the total immigration, and the yearly average.

2. From the numbers in the preceding question compare the emigration from Great Britain to New York with that from Ireland; and find what the emigration from Germany would reach if maintained at the same rate for one hundred and twenty-eight years.

3. In 1878 the post office carried one thousand four hundred and seventy-eight million of letters at an average of 1 dd.; what was its revenue?

Section II.

Make out one of the following bills :---

17 pairs of blankets at 8s. 9d. per pair.
14 pairs of stockings at 1s. 6 d. per pair.
4 dozen pairs of gloves at 2s. 3 d. per pair.
16 yards of cloth at 8s. 9 d. per yard.
15 lbs. of wool at 4 d. per lb.
19 yards of lace at 2s. 7d. per yard.

Or,

13 bars of soap, each weighing 3½ lbs., at 3½d. per lb.

12 packets of candles, each containing 51 lbs., at 101d. per lb.

31 lbs. of coffee at 1s. 4½d. per lb. 17 lbs. of tea at 2s. 3½d. per lb.

19 lbs. of currents at 42d. per lb.

Or,

5 chests of tea, each 2 qrs. 11 lbs., at 3s. 8d. per lb. 3 hhds. of sugar, each 13 cwt. 2 qrs., at £1, 19s. 4d. per cwt. 3 cwt. 1 qr. 14 lbs. of coffee at £2, 9s. 6d. per cwt. 14 cwt. 2 qrs. 3 lbs. of cheese at $5\frac{1}{2}$ d. per lb.

Section III.

1. I received £754, 5s. for goods which cost me £800; what was my loss per cent.?

2. Two pieces of cloth of the same quality contain 54 yds. and 63 yds., and the longer is worth £1, 7s. more than the shorter; what is the value of a third piece containing 120 yds.?

3. The sun passes through 360 degrees in 24 hours; how many degrees, minutes, and seconds does it pass through in 3 h. 19' 20"?

Section IV.

1. What is the number of which the half, together with the onethird, one-fourth, one-sixth, and one-twelfth, is 32?

2. Find the value of \(\frac{2}{3} \) of \(\frac{4}{3} \) of \(\frac{

3. How is a decimal quantity turned into a complex number? Express 8.12375 hours in hours, minutes, and seconds.

Section V.

1. What must I invest now at 5 per cent. simple interest that four years hence I may have £48?

2. The sum of two numbers is 33, and their difference is equal to

? of the greater; what are the numbers?

3. A merchant borrowed £3973 at a bank for two years, and when he repaid it deposited £2979, 15s. at the same rate of interest. How long must he leave his deposit that the interest on it may equal that on the loan?

Section VI.

1. Explain how it is that the processes of addition, subtraction, and multiplication are performed more simply with decimal fractions than with vulgar fractions.

2. What do you understand by the proof of an arithmetical opera-

tion? By what method do you prove a sum in addition?

Paper 42.

FEMALE CANDIDATES. Second Year.

[Two-and-a-half hours allowed for this paper.]

No candidate is permitted to answer more than ten questions. The solution must in every instance be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

1. A party of 25 persons, men and women, dined together; each man was to pay 2s. and each woman 1s. 9d., and the bill came to £2, 9s. How many women were there in the party?

2. A gang of 50 men earned a certain sum in 15 days. Had they received £12, 10s. more, they would have earned 5s. a day each; how much a day did each of them earn?

3. Find the exact time between 8 and 9 at which the two hands

of a watch will be together.

4. How many hours a day must 11 men work to dig in 9 days a trench which 6 men working 12 hours a day could dig in 18 days?

5. Three young men invested £3764 at 5½ per cent. simple interest, and sailed to Australia. The amount they received on their return was £5006, 2s. 5d. How long were they away?

6. In 1876 the people of the United Kingdom, taken at thirty-six million eight hundred and ninety-four thousand two hundred and forty-seven, consumed 1.27 gallon of spirits and 0.56 gallon of wine per head. Find the total consumption of spirits and wine in hogsheads of sixty-three gallons.

7. Four workmen were paid £6 for a piece of work. The first had worked 20 days, the second for 24 days, the third for 21 days, and the fourth for 15 days; what was the share of each of them?

8. If a guinea is worth 21 shillings, 24,990 shillings are worth 2647 Hungarian ducats, 3165 ducats are worth 1190 Dutch ryders, and 20 ryders are worth 633 francs; what is the value of 100 guineas in francs?

9. Three partners made a profit of £3140. The two first put into the business £3660; the second and the third put in £4880, and the first and third put in £4020; what profit should each of the partners take?

10. What is the present value of a bill for £4850, payable in thirteen months and a half when the rate of interest is 2 per cent.

for a month?

11. If when a child attains the age of 14 years £50 were placed for him in the Post Office Savings Bank at 2½ per cent. com-

pound interest payable yearly, how much could he draw out on

12. A man bequeathed half his property to his son, a third part to his daughter, and his widow, who took the remainder, received £400. Find the value of the property, and the portions of the son and daughter.

13. An officer bought a certain number of horses for £4500, and paid for each horse nine times as many shillings as there were horses; how many horses did he buy?

14. Four numbers are to one another as 3, 5, 7, 11, and the sum

of the two first is 128; find the four numbers.

Paper 43.

CHRISTMAS, 1880. (Male Candidates. First Year.)

[Two-and-a-half hours allowed for this paper.]

Candidates are not permitted to answer more than ten questions. The solution must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

1. (a) Distinguish briefly between notation and numeration.

(b) Write down the prime numbers between 196 and 225.
 (c) Express in words MDCLXVIII.

(d) A horse dealer buys 300 horses at a total cost of £12,600; he gains on each of one hundred horses as many crowns as there are guineas in the average cost, on each of another hundred as many shillings as there are pounds in the average cost, on the third hundred he gains £6 a head; find the total and the average gain.

2. An article is composed of two materials in the ratio of 1:2; the former costs 4s. 8d. per cwt., the latter 11d. per lb.; allowing 8d. per quarter for expenses of manufacture, find the total gain on

3 tons when the article is retailed at 1s. 11d. per 7 lb.

3. The duty on wine in cask is lowered from 1s. to 10½d. per gallon, but is raised on wine in bottles from 1s. 6d. to 2s. per dozen; find the total gain to the revenue if the quantity imported in casks increases from 30 millions to 37 millions of gallons, but the quantity imported in bottles falls from 31 millions to 22 millions of dozens; find also the total increase in the quantity imported, reckoning 6 bottles to the gallon.

4. At an agricultural show 131 horses compete in 9 classes; the numbers entered in each class are 18, 13, 15, 16, 10, 11, 12, 15, 21 respectively, and the corresponding prizes are 20, 18, 16, 15, 14, 12, 10, 8, 6 pounds respectively; assuming the average value of the horses in each class to be proportioned to the prize offered, and the average value of those in the fourth class to be £60, find the average value of each of the 131 horses.

5. Assuming the purchasing value of shillings, marks, and florins to be as 689:645:1345; find the loss on a draft for £100 if $\frac{2}{34}$ is paid in shillings, $\frac{1}{33}$ in marks, and the rest in florins, reckoning 20

marks and 10 florins to the pound.

6. Two trains start together from the same terminus; the first travels 297 miles in 14 hr. 51 min., the second 176 kilometres in 11 hr. 44 min.; find the interval between them when the first train has travelled 50 miles. (A metre = 3 ft. $3\frac{1}{3}$ in.)

7. A and B can do a piece of work in 344 hours, B and C in 34 hours, A, B, and C in 244 hours; if A and B work for 2 hours,

how long will A and C take in finishing it?

8. Make out the following bill:-

236 tons of coal at 1s. 9d. per cwt. 985 gal. of oil at $8\frac{1}{2}$ d. per qt. 87 score of faggots at $4\frac{3}{2}$ d. per faggot. 150 gross of nails at $2\frac{1}{2}$ d. per 3 doz. 900 poles at $2\frac{1}{2}$ d. per $\frac{1}{2}$ doz.

9. Find the sides of two squares which contain together 196 ac. 1 po. $5\frac{\pi}{2}$ yd., the sides of the squares being in the ratio of 21:28.

10. A cubical block of marble contains 1869959 168 cubic inches, and is enclosed in a box \(\frac{3}{2}\) of an inch thick; find the edge of the box.

11. If 20 men can dig a trench 37 yards long, 4 feet wide, and 9 feet deep in 18 days of 9 hours each, how many days of 10 hours each will 50 men require to dig a trench 100 yards long, 8 feet broad, and 18 feet deep, the labour increasing by one third on the average for every 9 feet of depth?

12. Find the increase in annual income produced by transferring

a sum of £4500 from consols at $98\frac{7}{16}$ to $4\frac{1}{2}$ per cents. at $96\frac{1}{4}$.

13. If I sell a horse for £62 and a cow for £26, I gain 10 per cent. on the original cost of both; but if I sell the horse for £63 and the cow for its original price, I lose 10 per cent.; find the original cost of each.

14. A mother and 2 children start for a long voyage; at starting their united ages amount to 35 years, and were in the ratios of 356: 39:25; on arriving the ages of the mother and the eldest child were in the ratios of 728:94; find the length of the voyage and the

ratio of the youngest child's age to the mother's on arrival. (Reckon-

ing 12 months to the year.)

15. A tradesman has on his books 960 customers whose monthly custom averages in each case £5; he sends out his bills at the close of each month and allows 5 per cent. discount to each who pays ready money, but charges $2\frac{1}{2}$ per cent. interest for each complete calendar month for all outstanding bills; at the end of a certain month one half of these bills have been outstanding for one month, one third for two, and the rest for three months; find the ratio of ready-money customers to the others, if the discount paid to them is equal to the interest charged to the others.

16. A passenger starts from New York to San Francisco at 8 A.M. on January 31, and trains leave San Francisco for New York each morning at the same hour; he passes 14 of such trains on his way and arrives at San Francisco 41 hours after he has passed the 14th; find the distance between the two places, the trains travelling at a uniform rate of 600 miles per day, and the day and hour at which

the 13th train that he has passed will arrive at New York.

Paper 44.

FEMALE CANDIDATES. Second Year.

[Two-and-a-half hours allowed for this paper.]

No candidate is permitted to answer more than ten questions. The solution must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

1. If 4 horses plough 45 acres in 10 days, in what time will 6

horses plough 81 acres?

2. The number of letters delivered in the United Kingdom in the course of the year 1839 was eighty-two millions, four hundred and seventy thousand, five hundred and ninety-six. In the following year, the penny postage being introduced, their number reached one hundred and sixty-eight millions, seven hundred and sixty-eight thousand, three hundred and forty-four. Find, to 4 places of decimals, the increase per cent., and the gross revenue of the Post Office in the latter year, at an average of 1½d. per letter.

3. How many prints of an engraving must a publisher sell, at a guinea and a half each, in order to gain 51; per cent. on an outlay

of £250 ?

4. If £1948 be gained in 5.25 years at 3 per cent. simple interest, what was the sum invested? (Answer to decimals of 1d.)

5. One workman receives per week 09 of £7, 10s., another 72916 of a guinea. How much more will the latter have received than the former at the end of a year (52 weeks)?

6. An English mile is 2136 of a German mile. How long will a man, who walks 4 English miles an hour, take to walk a German

7. A soldier has 5 hours' leave of absence: how far may he travel in a coach which goes 10 miles an hour, to return to camp in time, walking 4 miles an hour?

8. If for a loan of 30s. I receive 25 of $\frac{1}{14}$ of $\frac{2}{3} + \frac{1}{4}$ of 8 guineas,

what is my interest per cent.?

9. Divide £2, 15s. among A, B, and C, so that for each threepenny piece received by A, B may receive a fourpenny piece; and that there shall be as many shillings in the sum received by C as there are sixpences in the sum received by B.

10. Divide £177, 7s. 0_{4}^{2} d. among 4 persons in the proportion of

 $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{8}$, and $\frac{1}{8}$.

- 11. A invests £457, 10s. at compound interest for 3 years at 4 per cent., and B £477, 10s. at simple interest for the same time at the same rate. How much more interest will the one receive than the other?
- 12. If the penny-a-mile railway fare be 40 per cent. below secondclass fare, and the second-class fare be 30 per cent. below the firstclass, and if return tickets are issued at a fare and three-quarters, what ought to be the price of a first-class return ticket for 250 miles?

13. If 12 ounces of bread are sold for 4d. when wheat is £6, 13s. 4d. a load, what must have been the price of wheat per load when 8

ounces of bread cost 6d.?

14. A crown made of gold and silver weighs 150 ounces, and displaces 13.824 cubic inches of water. Had it been of pure gold it would have displaced 12.96 cubic inches of water, and had it been of pure silver it would have displaced 23.04 cubic inches. Find the weight of gold and of silver in the crown.

Paper 45.

FEMALE CANDIDATES. First Year.

[Two-and-a-half hours allowed for this paper.]

No candidate is permitted to answer more than ten questions.

The solution must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

1. The distance from the sun of the planet Mercury, is thirty-five millions three hundred and ninety-three thousand one hundred miles; of Venus, sixty-five millions one hundred and thirty thousand; of the Earth, ninety-one millions four hundred and thirty thousand; of Mars, one hundred and thirty-nine millions three hundred and twelve thousand; of Jupiter, four hundred and seventy-five millions six hundred and ninety-three thousand; of Saturn, eight hundred and seventy-two millions one hundred and thirty-five thousand; of Uranus, one thousand seven hundred and fifty-one thousand; of Neptune, two thousand seven hundred and forty-six millions two hundred and seventy-one hundred and forty-six millions two hundred and seventy-one thousand. Add these numbers together and find the average distance of the eight planets from the sun; give your answer in words, as well as in figures.

2. If the circumference of a circle is three and one-seventh times as great as its diameter, what is the length of Mercury's journey in

travelling round the sun?

3. Make out the following bill :-

39½ yards of Brussels carpet at 5s. 4d. a yard. 62¼ of Kidderminster at 3s. 6d. 27 of cocoa-nut matting at 1s. 7d. 34½ of drugget at 2s. 3d. 43½ of Indian matting at 1s. 1d. A Turkey carpet containing 90 square yards at 1½ guinea per yard.

Or,

4. 5 tons 12 cwt. 2 qr. 14 lb. at £1, 6s. 8d. per ton. 11 tons 17 cwt. 1 qr. at £7, 6s. 8d. per ton. 18 cwt. 1 qr. 21 lb. at 5.5d. per lb.

18 cwt. 1 qr. 21 lb. at $5\frac{1}{16}$ d. per lb. 5. If the rent of 39 ac. 2 r. 20 po. be £148, 11s. $10\frac{1}{2}$ d., what would

be the rent of 6 acres?

6. A bankrupt's effects amount to 2548 guineas, and his debts

to £3057, 12s. How much can he pay in the £?

7. A gentleman gives away in charity is of his income, and pays to of it in rates and taxes; with these deductions he has still £473, 13s. 1d. left. What is his gross income?

8. Find the value of '416 of 5 guineas; and of '48i of 11s. 3d.

9. How much must be added to $\frac{7}{16}$ of $1\frac{1}{3}$ guineas to make $\frac{9}{10}$ of £3\frac{3}{3}?

10. There are two numbers, of which the larger is 39.61, and the two added together make 65. Give the product of the two numbers to three places of decimals.

11. In what time will £229, 10s. amount to £258, 3s. 9d., at 5 per cent. per annum, simple interest?

12. Find the simple interest on £4258, 6s. 8d. for 198 days at 3\frac{1}{2} per cent. per annum.

13. On what principal will the simple interest at 4.5 per cent. for

5 years amount to £168.778125?

14. Describe as you would to children, and illustrate by an example, what is meant by (a) Interest, (b) Proportion, (c) Multiplication by Factors, (d) Decimal Coinage.

London University Matriculation Questions.

Paper 46.

JANUARY 1877.

1. Find the sum of the fractions 3, 5, 7, 8; subtract the sum of the fractions \(\frac{1}{2}\), \(\frac{3}{4}\), \(\frac{1}{8}\), \(\frac{7}{8}\); and exhibit the result in its lowest denomination.

2. Reduce the two sums of the preceding question and their difference, separately, to decimals; and verify by subtraction the accuracy of your results.

3. Extract to the nearest integer, by the ordinary, or by any other

process, the square root of 12345678987654321.

4. Calculate to the nearest farthing, by whatever process you consider the most convenient, the cost of 19 tons 19 cwt. 3 qr. 271 lb. of merchandise at £19, 19s. $11\frac{1}{2}$ d. per ton.

Paper 47.

JUNE 1877.

1. Divide $\frac{25}{21} + 6\frac{3}{8} - 7\frac{1}{28}$ by $5\frac{3}{3} - 3\frac{1}{7} + \frac{17}{12}$, and multiply the result by $6\frac{5}{18} + 9\frac{7}{25} - 13\frac{1}{8}$.

2. Find what fraction of a guinea is equal to the difference between

a of a crown and a of a shilling.

3. Calculate to five places of decimals the fraction

 3.70271×64732 .043679

4. Reduce the circulating decimal 1.52372 to a vulgar fraction in its lowest terms.

5. Extract the square roots, to five places of decimals, of the numbers, 3.9726523, 39726523, and 039726523.

Paper 48.

JUNE 1879.

1. Add together $\frac{3}{11}$ of $\frac{3}{87}$ of $\frac{1}{84}$ of a pound, and $\frac{3}{83}$ of $\frac{57}{88}$ of $1\frac{3}{4}$ of a shilling, stating the result as a fraction of half-a-crown.

2. Multiply 123:456 by 654:321 correctly to the nearest integer. 3. Obtain the square root of 0.001111111 correct to seven places

of decimals. Multiply the result by the square root of 7.29.

4. Having given that one foot is 0.3048 of a metre, what is an acre in square metres? If 13 cubic feet of stone weigh a ton, what will a cubic metre weigh in kilogrammes? (A kilogramme may be taken as 2½ lb.)

5. Reduce 1.45678 to a vulgar fraction, proving the truth of any rule regarding recurring decimals which you may require to

6. A coal-pit has an output of 1000 tons a week, which is sold for £370; the price of large coal is 10s. a ton, of slack 4s. a ton; how much of the 1000 tons is slack? If the slack costs the coalowner 6s. and the large coal 7s a ton, what are his profits per week?

Paper 49.

JANUARY 1880.

From 112 of 13 of 23 of a mile subtract 35 of 28 of a foot, and express the result in metres. (One metre = 393 inches.)
 Multiply 0.0316228 by itself, giving the result correctly to six

significant figures.

3. Obtain the square root of 0.03456789 correctly to seven places of decimals.

4. Find the product of 0.538461 and 0.3285714, reducing the

result to a vulgar fraction expressed in its simplest form.

5. Given that a gallon of water weighs 10 lb., that a cubic foot of water weighs 1000 oz., and that a litre is a cubic decimetre; find how many litres there are in a gallon.

Paper 50.

JUNE 1880.

1. Multiply together 0 001234 and 0 07890; divide the product by 34 56, and extract the square root of the quotient, giving the result to three significant figures.

2. Assume that 6 men can do as much work in an hour as 7 women, and 8 women as much as 11 boys, and that 5 men can do a certain piece of work in 10 hours. How long will it take 1 man, 2 women, and 3 boys together to do the same piece of work? Express the result decimally.

3. A plot of land is sold at £1200 per acre. What is the price in francs per square metre? (Assume £1 = 25 francs, a metre = $39\frac{3}{8}$ inches, an acre = 4840 yards.)

4. Á reduction of 30 per cent. in the price of eggs would enable a purchaser to obtain 54 more for a guinea. What may the present price be?

Paper 51.

JANUARY 1881.

- 1. Express $\sqrt{\frac{0.00456 \times 0.987}{6.54}}$ as an ordinary decimal fraction, correct to three significant figures.
- 2. Express $\sqrt{1.27} \times 1.571428$ as a vulgar fraction, reducing it to its simplest form.

3. What is 1s. 6d. per gallon in francs per litre? Express the result decimally, correct to four significant figures.

- [A gallon of water weighs 10 lb.; a litre is a cubic decimetre; a gramme is the weight of a cubic centimetre of water; and you may assume that a kilogramme is 2½ lb., and that £1 is equal to 25 francs.]
- 4. Assume that 4 English navvies can do as much work in a day as 5 French navvies, that 4 French navvies can do as much as 7 negroes. It is found that 13 English and 12 French do a piece of work in 3 days. How long will it take 10 negroes? Express your result decimally to three significant figures, and use none but Arithmetic symbols in your work.
- 5. A milk dealer buys pure milk at 11½d, per gallon. How much water must he add that he may sell it at 5d, a quart and obtain a gross profit of 100 per cent?

Paper 52.

JUNE 1881.

- 1. Express $\sqrt{\frac{0.0132 \times 0.543}{7.65 \times 0.0301}}$ as a decimal fraction, correctly to three significant figures.
 - 2. Reduce $\frac{0.90 \times 0.846153}{0.461538 \times 0.83}$ to its simplest form.

3. Express $\frac{6}{8}$ of $\frac{13}{8}$ of $\frac{2}{8} + \frac{6}{8} \times \frac{1}{8} + \frac{3}{4} - \frac{1}{30}$ of 31 as a vulgar frac-

tion in its simplest form.

4. A reduction of 20% in the price of beef would enable a purchaser to obtain 6 lbs. more for a sovereign. What is the reduced price?

5. [See Example LXXV.]

6. A ton of stone measures 13 cubic feet; what does a cubic metre weigh in kilogrammes?

[Assume 1 metre (linear) = 39% inches; 1 kilogramme = 2½ pounds.]

THE END.



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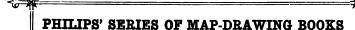
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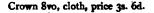
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Cheshire			~	e	Middlesex		•	_
CHERMILE				U	midulesex		21	U
Derbyshire			7	6	Northumberland		7	6
Durham			7	6	Nottinghamshire		7	6
Kent			7	6	Staffordshire		12	Ō
Lancashire and	Cheshi	re	16	0	Warwickshire	•••	7	6
Lancashire			10	6	Yorkshire		10	6
Lincolnshire			12	0		,	-•	•

* Other counties in prepara

George Philip

and Liverbool.